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How a Large Pump Casing Was Molded and Cast

A Green-Sand Skin-Dried Mold Was Used With Dry-Sand Core Made on the Floor with the Mold and Dried in an Oven

PERHAPS in no other branch of the foundry business is the molder's skill, ingenuity and judgment so taxed as in the production of large steel castings of complicated design, comparatively thin sections, or both. An interesting example of this class of work is the casing for a large centrifugal pump shown in the accompanying illustrations. It was made in a prominent steel foundry in Milwaukee. The casting weighed 83,530 pounds, or over 40 tons. This will give some idea of the amount of work involved in preparing the mold. The general features of the casting are shown in Fig. 1. It consists of a circular case about 17 feet in diameter somewhat resembling a snail shell with a large water-entrance connection approximately 4 feet in diameter cast tangentially on one side. A branch pipe connection joins the main water-entrance connection as illustrated, forming a large Y. For convenience in machining and assembling the casting is made in two parts, which are, however, both cast at one time and in one piece. The two parts are joined in the mold by the connecting fins shown in Fig. 1, on the upper one of which a man is standing. Foundrymen who have had experience with this class of work know that better results are secured by this method than by casting each half separately; besides there is a saving in time, space and labor which more than offsets the slight trouble of cutting out the connecting pieces. The job was molded in the floor using a bolted-up cast-iron drag and a cope of similar construction. The cope, for convenience, was made in halves, one half covering each part of the casting. The core was also made in halves right in the floor and joined together rigidly before the mold was finally closed and poured. Taking them in order, the illustrations show the different steps after the pattern was drawn and the mold finished and dried. Before reaching that stage, however, considerable work had to be done, a brief description of which may not be out of place. A shallow pit was first prepared and four binders laid across the bottom. Sand was next rammed firmly between them and struck off flush with the top. On this bed the bottom plate was lowered and tapped down solid. The drag was next assembled on the bottom plate, squared up and

FIG. 1—THE CASTING, CONSISTING OF TWO PARTS, WEIGHED OVER 40 TONS

FIG. 2—DRAG HALF OF MOLD WITH PORTION OF CORE IN PLACE SHOWING BRANCH CORE IN FOREGROUND. FIG. 3—LOWERING ONE-HALF OF THE COPE OVER MOLD

leveled. The joint side of the flask was machined prior to assembling, so that when in its place ready for the sand, the joint was on a perfect plane. The importance of this will be appreciated by those who have to true up skeleton patterns. Bearings for the core prints were then built up solid from the bottom plate to approximately the right height.

A coke bed was next laid and rammed down firmly and a bed of sand about 4 inches thick placed on top of it. The bottom half of the pattern was then set up on blocks. A long straight-edge was set across the joint and the pattern wedged up until it touched all over. It was then weighted to prevent shifting, the core bearings adjusted to the right height and the ramming proceeded. The inside joint was then made and the core arbors set. These arbors, in addition to being provided with hooks for lifting, also had lugs and bolt holes at the ends so they could be fastened rigidly to each other before finally closing the mold.

When the core was rammed up to the joint, the top half of the pattern was set on; the rest of the core rammed and the parting made for the cope. A ring about 2 feet smaller than the opening in the casing was rammed in the center to lighten the core and for other purposes which will appear later. The cope was then put on and the bars adjusted so the risers might be placed where necessary. It is of interest to note that there were 14 of these risers altogether, with a combined weight of about 6000 pounds or nearly 7 per cent of the total weight of the casting. This cope was in two parts, or more properly speaking, there were two copes, one for each half of the casting; for as Fig. 3 plainly shows, although the mold is made in one piece and poured as a unit, still there were really two separate and distinct castings.

After the copes were rammed they were lifted off and each of them set on four piers made of small round iron flasks, one pier being placed under each corner. They were then finished overhead, nailed all over their faces, the brackets were cut, the surfaces whitewashed, and the risers cut out to the right shape and size. Pieces of sheet iron were then leaned up against the cope all around and two oil burners introduced and manipulated about until the mold was dry. The joint on the drag was then cleaned away and boards laid all over it on which to stand; then a thickness of sand equal to the metal-section of the casting was cut out between the ribs of the pattern, after which it was lifted off and the top of the core finished.

Like the cope, each half of the core was handled separately and it required some maneuvering to get a level lift.

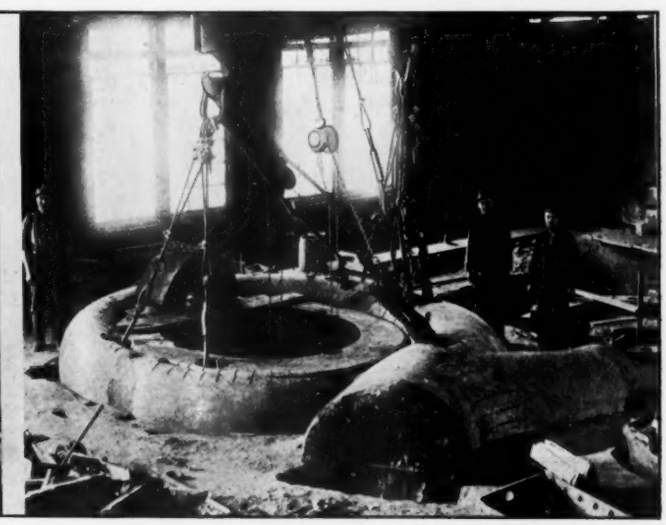

FIG. 4—THE CORE WAS JOINED TOGETHER IN ONE PIECE AND HANDLED BY SLINGS. FIG. 5—LOWERING THE CORE INTO PLACE AFTER TESTING THE RIGIDITY OF THE JOINTS

However, with the aid of turnbuckles, chain blocks, pieces of rope and wire slings, it was at last accomplished and the cores finished, nailed, bracketed, whitewashed, placed on the core-oven car and shoved into the oven. The proper thickness of sand was then taken out of the bottom half of the pattern and the latter drawn out of the sand and put away. The mold was finished and the gates, which are quite distinctly shown in Fig. 3, were cut.

It is interesting to note here how foundry practices change. A few years ago no one would think of pouring a job like this except through a bottom gate. Here we have an ordinary gate cut in the joint, no different from the gate one would expect to see if the job were to be poured with iron.

After the mold was whitewashed, and as a preventative of cracks and draws, a large number of spikes were inserted in the brackets at *A* and *B*, Fig. 4. A bent rod was also introduced and supported on spikes where the pocket *A* joins the main body. The drag was then covered with sheet-iron and dried with torches in the same manner as the cope. When the drag was sufficiently dry the cores were lowered back into their places.

Blocking between the cores was placed with a wedge at each block to allow for release after the casting was set; then the bolts were tightened up and the space between filled with sand, as will be seen by referring to Fig. 3. The cores which form the recess around the rim were set in their places and held up by wedges; there were two hooks on the back of each core to which wires were fastened, these wires ran back through the wall of the mold and were twisted around rods, two of which can be seen in the illustration. When the wires were tightened the wedges were removed. The core forming the pocket *A*, Fig. 4, was located before lowering the main core, but the small branch core *C*, Fig. 3, was not placed until the main core was set. It was then put in place and butted hard up against the main core. When everything was ready the copes were tried on and off and set down. Then the core, all in one piece this time, was lifted to see if the thickness was all right and for other general foundry reasons, but principally to be sure that the connecting gear between the two cores was rigid for on this point depended whether the core would stay in its place or not when the metal got under it. The evidence being satisfactory, and after all dust and other small particles had been blown out with an air hose, the core was replaced and the copes lowered on again.

Standards for holding down the core were set in their places, then the joint of the flask was bolted together, sand packed between the copes, the binders set and the runners and risers made up. The long bolts connecting the binders were screwed up and the mold was ready for the steel. This was poured from two 50,000-pound ladles, one on each side. When the metal appeared in the risers, pouring was checked and then resumed slowly, and the risers filled gradually. After the casting was poured and set, the sand was dug out between the copes and cores and all the blocking and wedges removed. This gave the casting a chance to contract. The next day the copes were taken off and the casting lifted out. The completed casting with the core removed is shown in Fig. 1.

FIG. 6—MOLD WITH BRANCH CORE IN PLACE AND HALF OF CORE ON OVEN-CAR READY TO BE PUT IN THE MOLD

Holcroft & Co., Detroit, designers and builders of foundry furnaces and ovens, have opened an eastern office in the Real Estate Trust building, Philadelphia. This office will be directed by E. V. Holcroft, who until recently was manager of the William Kennedy & Sons plant at Collingwood, Ont., and William H. Holcroft, formerly of Chester, Pa.

Electric Furnace for Melting Nonferrous Metals--I

Three General Classes of Furnace are Used—Continuity and Dependability of Service Tend Toward Low Operation Cost

By Edgar F Collins

THE earliest furnaces for melting nonferrous metals were probably the charcoal forges, and following this all classes of fuel-fired furnaces have been utilized with varying degrees of success, until we come today to the electric furnace as the latest type asking for the opportunity to demonstrate to the nonferrous metal founder that it is free from many of the physical, chemical and economic handicaps inherent in the brass furnace of the past.

Satisfactory and economical melting of nonferrous metals and alloys requires a furnace which prevents oxidation of metals or alloys while in the furnace, and, in fact, deoxidation of metals or alloys in some degree is usually advantageous. Freedom from volatilization of metals should exist subsequent to their liquefication and while in the molten state so as to prevent loss of metal in the form of escaping vapor, which usually oxidizes upon its escape from the furnace to air when the furnace atmosphere is neutral or reducing.

Slags which come from overheated linings, dirt from scrap, oxides from metals and other sources must be prevented to permit dry skimming during melting. Otherwise, the entrained metal in the form of shot in the fused slag, must be reclaimed by a more or less elaborate process of crushing the slag. A furnace should not require the maintenance of an elaborate and expensive reclaiming plant. In other words, impurities should float on top of the bath in the furnace in dry powdered form and be easily skimmed from the surface of the bath. It should permit the use of sal ammoniac or other flux to aid in cleaning the metal while molten in the furnace, but it should not regularly require the use of such flux to give perfect metal; neither should the bath require a charcoal covering while melting or being held in the furnace. Uniformity of alloy and absence of segregation should exist when the furnace charge has reached the pouring stage. Test bars should show uniform physical characteristics throughout their length, an alligator surface, a perfect fracture, and satisfactory crystallization and lack of segregation under microscopic examina-

This article is a paper read before the Cleveland Engineering society recently by the author, who is engineer of industrial heating of the General Electric Co., Schenectady, N. Y.

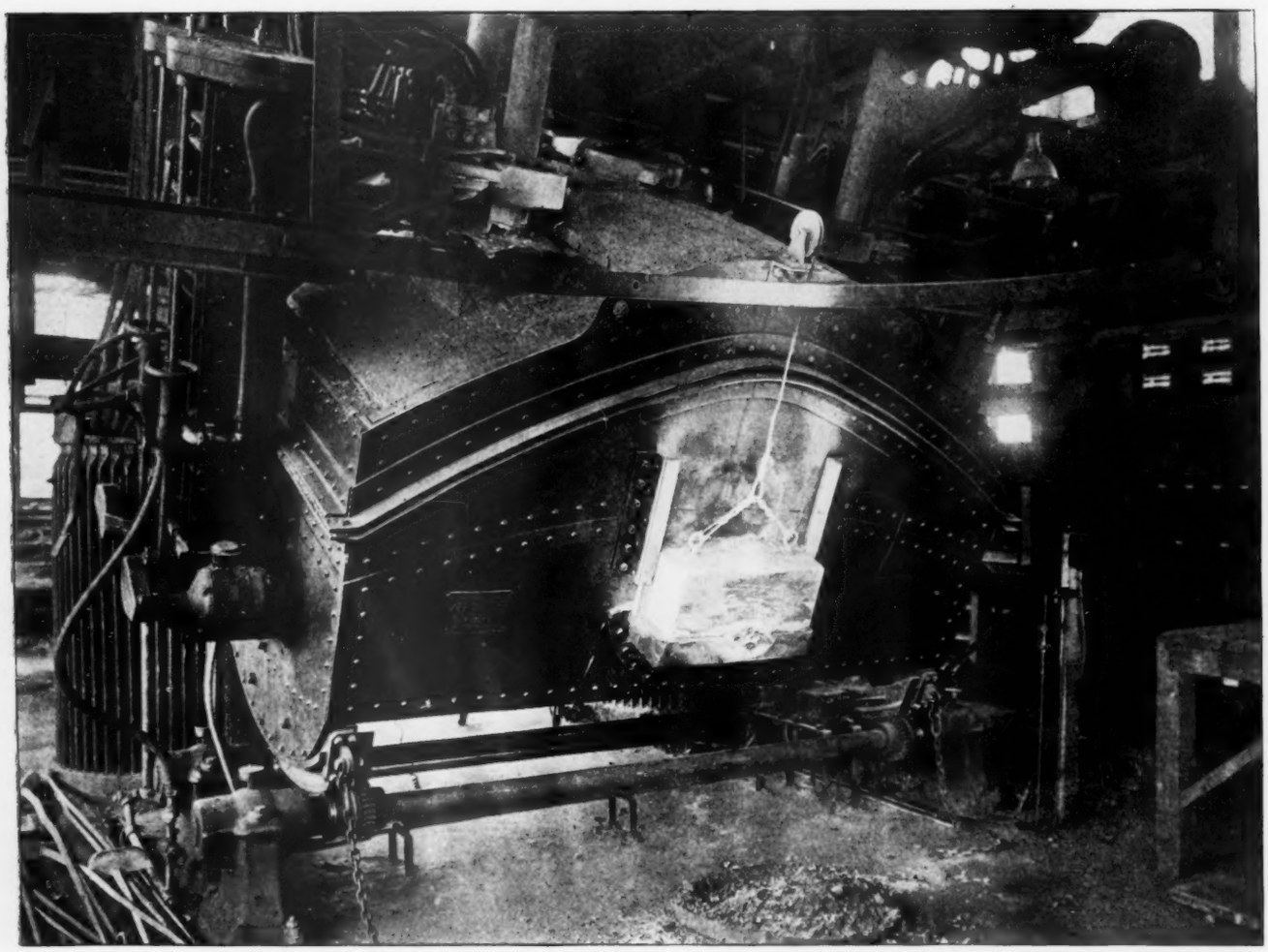

FIG. 1—A 1500-POUND, 300-KILOWATT BRASS MELTING FURNACE INSTALLED IN A NONFERROUS FOUNDRY

tion. Furnace linings and the atmosphere must be free from the slightest degree of sulphur and the oxygen supply when melting copper or other alloys rich in copper must be controlled in order to produce satisfactory foundry castings of sound metal, since copper greedily absorbs sulphur and oxide, thus giving trouble in cooling. In fact, the furnace melting chambers should be free from contaminating influences and should have a controllable oxygen atmosphere. Under these conditions electrolytic cathodes, free from salts of the electrolytic bath, may be melted down and poured at pitch without rabbling and poling, thus eliminating the use of the present-day reverberatory copper refining furnace. Brass may also be made directly from cathode copper as well as cathode zinc, thus saving one refining operation on copper and one melting or pigging operation on zinc.

Large Furnace Promotes Economy

Large capacity furnaces which do not involve the use and handling of crucibles are desirable where local conditions will permit. Large furnaces promote economy, due to higher thermal efficiency; saving of floor space in proportion to metal melted; saving in labor; saving in cost of lining per ton of metal melted, especially when compared to crucible cost, and their storage, drying and tempering; and spill from broken crucibles.

Where metal is melted in large furnaces, preheated hand ladles or crucibles are used to transfer the metal to the molds, especially where small foundry castings are being made, and it is important that these ladles or crucibles be well and properly preheated before using in order to get satisfactory work; when pouring small parts, such as ½-inch brass valves. Furnace linings should in the main be built from commercial refractories of moderate cost at all times available, such as standard fire brick and shapes, with limited use of special refractories where the results justify their employment. Special refractories, which can be procured only at high prices and with more or less difficulty and uncertainty, should be avoided. If the foundryman or metal melter will make repairs upon his linings at least once every two weeks and when in severe service once each week, his lining cost will be much less than when special high priced refractories are used and repairs and inspection of linings are less frequent. The refractoriness of lining should be such that it will not fuse or slag perceptibly at melting temperatures. The inner surface should be glazed over at temperatures above the metal melting zone, which guards against slag formation during the melting process, assuming that no chemical reaction occurs between metal and hearth to reduce the fusion point of refractory. As an illustration, the presence of lead in brass melting fluxes the refractories at temperatures at which they are immune when in contact with the same bath free from lead.

The melting chamber should be arranged so that its atmosphere may be reducing neutral or oxidizing for certain metals and alloys, in other words, its oxygen should be controlled. A certain flow of gas through the furnace may be required at times while a dead or still atmosphere may be absolutely necessary at other times. No advantage, however, is secured in hermetically sealing the furnace unless some process of distillation is attempted. Hence, if doors are made to enter furnace it is only necessary that they close in such a manner and are of such construction as to prevent an undue loss of heat and circulation of gases in the furnace when they are closed. A single small opening in the furnace such as is required for stirring the bath or pouring may produce a sort of breathing of the furnace when the vent is open, but loss of heat or metal is not appreciable if the furnace is properly manipulated.

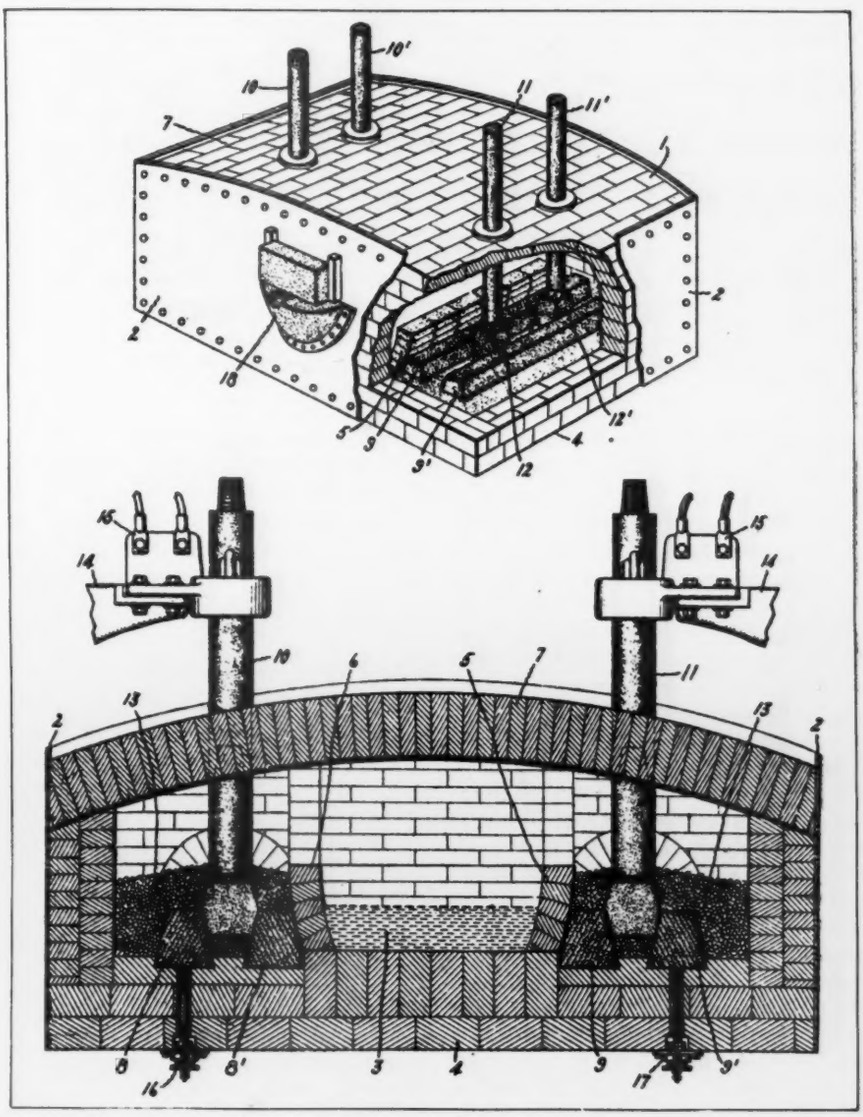

FIG. 2—DIAGRAM ILLUSTRATING THE PRINCIPLES OF THE CARBON ELECTRODE TYPE OF FURNACE

Shallow baths promote a more uniform and rapid melting and freedom from segregation than the deep bath. The source of heat should be a uniform mild soaking heat, and its temperature gradient above the bath should be moderate. This is due to a large absorbing surface; for the bath takes in a large quantity of heat at a low heat potential. This transfer of heat to the metal is accomplished most successfully by radiation to the top of the bath and conduction to the bottom. In case the source of heat is at only slightly high-

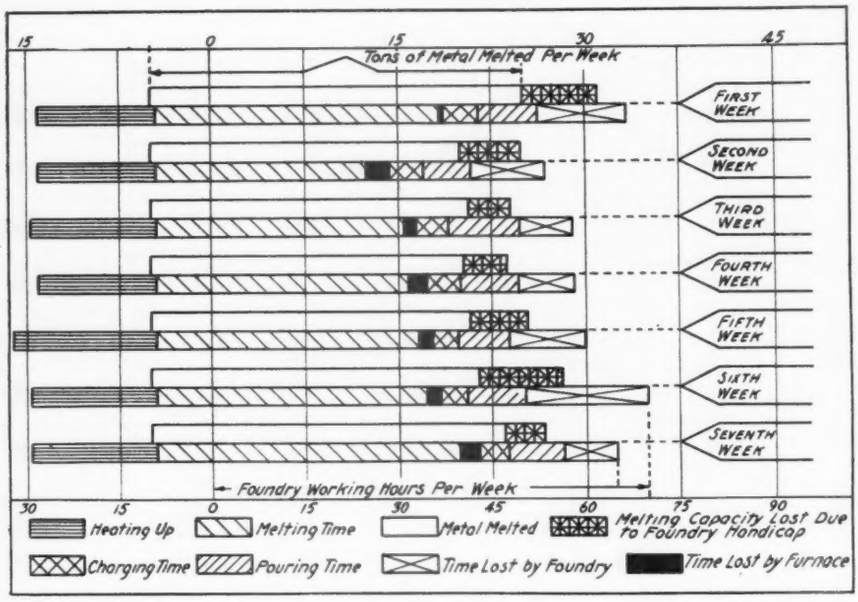

FIG. 3—THIS CHART SHOWS THE CONTINUITY OF ELECTRIC FURNACE SERVICE IN MELTING BRASS COMMERCIALLY

er temperature than the charge when the fusing point of metal is reached, the metal may be held for an indefinte period within that zone of temperature above the fusing point in which vapor tensions are not sufficiently high to cause appreciable loss of metal from volatilization. In other words, if the source of heat is such that its temperature lies in the temperature zone safely below the destructive distillation point of the metal, then the temperature of the bath can in no manner exceed it. A safe way of securing this heat control is to limit the temperature of the heat source by means of a pyrometer. Pyrometers that have a satisfactory life in certain brass furnaces are available at present. It follows from the foregoing that furnace design should be such as to allow the source of heat to be held at any temperature desired, just as one may vary the heat in a carbon filament carrying electric current, as against the same power expended in a carbon electric arc. The electric filament may have its temperature fixed at any point up to about 3000 degrees Cent., whereas, the carbon arc has a temperature of approximately 3000 degrees Cent., which changes little with the size or power of the arc so long as the arc continues to burn. Likewise, an efficient powdered coal flame or fuel oil flame is inherently a high temperature source. Heat distribution should be fixed and if possible automatically controlled. In other words, heat received by radiation as related to that received by conduction, should be such as to secure a uniformly heated bath. If any variation in the ratio of heat radiated to the top of the bath and that conducted to the bottom is permissible, this variation should permit the reduction of radiant heat at the top of the bath when the fusing temperature is reached, for subsequently, due to the fact that when the bath is liquid, its bottom convected heat will give uniformity of temperature to the bath.

How Furnaces Are Classified

Electric furnaces are commonly classified as to the method in which heat is developed. Accordingly there are three main classes. First come furnaces in which heat is developed by the passage of current through a solid, laminated or granular conducting medium or resistor; next are furnaces in which heat is developed by the flow of current throught a liquid or solid conductor; and finally we have furnaces in which heat is developed by the flow of current through gas or air. In the first class are three different types; first, the furnace in which the conducting medium consists of material that is to be treated; second, the furnace in which the heat developed in the resistor is transferred to the charge by conduction or radiation or both—in this type a wall may or may not intervene between the resistor and charge; and third, the furnace in which a readily controllable amount of heat is generated between a fixed and a movable carbon electrode. In the second class are two different types; the electrolytic and nonelectrolytic furnaces. In the third class is only one type of furnace, the one in which arcs play between one or more carbon electrodes and the charge to be heated.

All types of furnaces have been tried out for melting brass and other nonferrous alloys. Furnaces in the first two classes lend themselves readily to the generation and control of a mild soaking heat such as is required for melting volatile alloys. As an illustration, the common resistance furnace lies in the first class and the induction furnace in the second class. Furnaces in the third class generate a heat too intense and burning to be used with even questionable success in melting volatile alloys without the use of much skilled manipulation and watchfulness. Difficulty of control of the electric arcs in atmospheres high or low in volatile gases, the prevention of surging, the control of the power factor and high metal loss are some of the serious problems confronting the man who would melt volatile alloys in the arc furnace. Its employment, in the writer's judgment, had best be left for steel. The writer has had several years' experience with

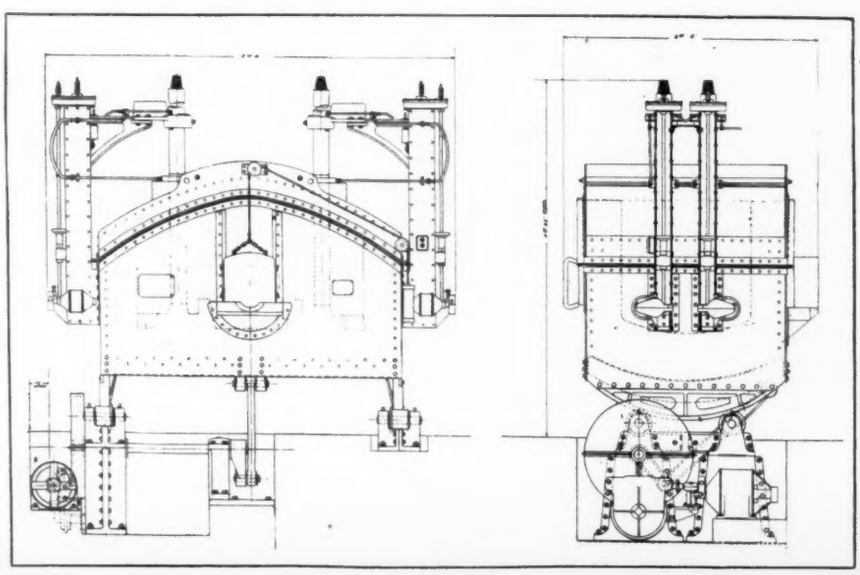

FIG. 4—WORKING INSTALLATIONS OF A BRASS MELTING FURNACE OF THE CONTACT ARC RESISTANCE TYPE

furnaces falling in the third type of the first class of furnace mentioned in the foregoing classification and it is upon experience gained from many tests as well as from commercial operation in the foundry that the basis of this article rests.

It is seen from the accompanying illustration, Fig. 2, that this type of furnace consists essentially of a refractory lined case within which are located the heating units lying on either side of the melting hearth (3). The source of heat (13) lies in a duct separated from the bath by carborundum walls (5) and (6). The duct is fitted with cross electrodes (9) and with wearing blocks (12) under each of two vertical electrodes projecting through the arched roof. These cross electrodes in the bottom of the duct as well as the wearing blocks between them and the vertical electrodes are carbon. The whole duct is filled with granular coke to the height of the bridge wall (5) and (6) on either side of the hearth. Neutral electrodes (16) and (17) make contact with cross electrodes (8) and (9). These neutral electrodes are for the purpose of automatic control as will be seen later. The vertical electrode carries a water-cooled ring where it emerges from the top arch; also a cable clamp for the electrode (15) is water cooled. The two vertical electrodes (11) are terminals of one phase while those marked (10) are terminals of another. In other words the furnace is inherently two-phase. By multiplying the two phases, however, it may be operated single phase, or by using Scott transformer connections it may operate from a 3-phase source of current. The phase voltage most satisfactory has been found to be 60 to 70 volts. By reference to Fig. 2, the detail arrangement of the electrodes in the resistor duct becomes plainly evident.

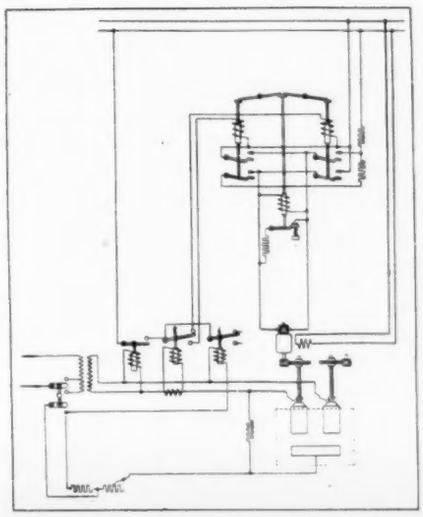

FIG. 5 — ELECTRIC WIRING DIAGRAM FOR A CONTACT ARC RESISTANCE FURNACE

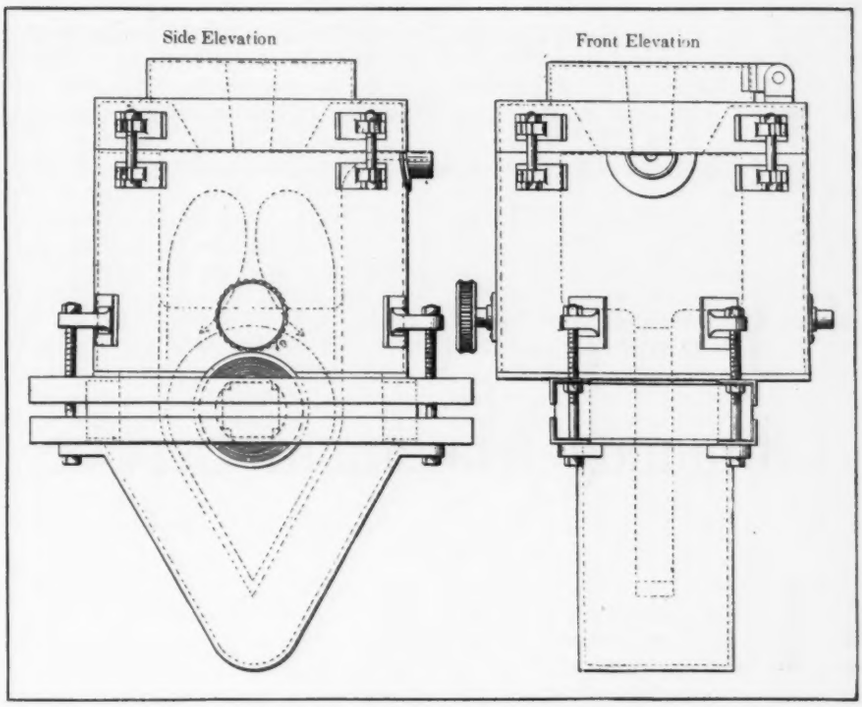

FIG. 6—FRONT AND SIDE ELEVATION DIAGRAM OF AN INDUCTION TYPE FURNACE

When generating heat, the current flows through the vertical electrodes (10) and (11), Fig. 2, through a short space filled with granular carbon to the wearing block (12), into cross electrodes (9) into a second wearing block (12) and out to the line through a second granular coke strata and vertical electrode. The value of the current is regulated automatically by varying the distance between the vertical electrodes and wearing blocks. In other words, by means of a current controlled relay the distance between one electrode and its wearing block is regulated and by means of a voltage-controlled relay, connected to neutral bottom electrodes and the other vertical electrode, the distance between this electrode and its wearing block is held to correspond to one-half of the phase voltage or 30 to 40 volts. A rheostat on a control panel regulates the current value and when once set for a given value, the current value remains constant until the rheostat position is changed by the furnace operator. Hence, the power input is automatically held constant and equally divided between the vertical electrodes. In starting with a cold furnace, heat is generated first in the granular carbon separator lying under the bottom face of vertical electrode which immediately becomes incandescent due to the current carried by the carbon granules and the heat generated in a multitude of contact arcs enveloping the lower end of the vertical electrode. Heat is at once taken from this source by the granular coke in the trench and its whole surface becomes heated to the desired point. The surface of the granular carbon radiates heat to the arched roof while the body of granular carbon and wearing blocks with cross electrodes conduct heat to the furnace walls and to the sides and bottom of the hearth with which they are in contact. Furthermore, as the furnace becomes heated, a certain amount of current flows from one vertical electrode to the other vertical electrode directly through the granular coke in a manner similar to that in the simple carbon resistance furnace. This heat may be as much as 30 per cent of that developed locally at each vertical electrode through contact arcs and resistance as above described. This heat is radiated largely to the roof, since the greater part of it is generated in the upper surface of the coke body. In addition to serving as an enclosing wall of the furnace, the roof is so shaped to act as a highly efficient reflector throwing the heat received from the incandescent coke ducts on either side of the hearth uniformly on the hearth or bath. This heat is very uniform and is called a mild soaking heat. Since a part of the heat is supplied to the bath from the bottom and sides, this soaking heat lends itself well to the melting of brass or volatile metals.

Some characteristics of this furnace which the writer believes make it essentially suited to melting nonferrous metals and their alloys are as follows: (a) The temperature of the heat generating source is controllable at will; (b) the heat generated is of

the mild soaking type, uniformly distributed, and any workable temperature gradient may be maintained between the charge and heat source; (c) the heat is received by the charge from above, from the sides and through the bottom; (d) the bath is comparatively shallow—approximately 6 inches in a 1500-pound furnace—and a large surface is exposed to the heat; (e) normally the furnace has a reducing atmosphere which may be made readily neutral or oxidizing; (f) the automatic control of power requires little attention; (g) the furnace atmosphere is free from contaminating gases; (h) a dead atmosphere exists normally in the furnace; (i) the temperature is controllable so that slags do not form in melting brass, with the result that metal recovery from dirt skimmed from the top of the bath in the furnace is simple; (j) the furnace may be forced, in other words, heat may be fed to the metal as fast as it is absorbed to give a high rate of melting; (k) the furnace has dependability and continuity of operation under commercial conditions. A continuity chart is shown in Fig. 3. The delays as shown due to the furnace were of short duration when compared to the time the furnace was delayed due to foundry conditions, in other words, little melting capacity was lost and charged to the furnace as compared to that lost due to delays for which the foundry was to blame. In Fig. 4 and Fig. 5 are illustrated working installations of a furnace with a melting capacity of 1500 pounds of brass per hour.

Obtaining Maximum Service From Crucibles

By A C Bowles

A FEW days ago a local foundryman called me up and complained that the last batch of crucibles he had received fell to pieces before he was able to get even one heat out of them. He asked indignantly what we were going to do about it. I told him that we would make good any crucibles proved defective, but that I would like to see the crucibles to determine the cause of their failure. I found he had attempted to dry them in the moist atmosphere of the core-oven, with the inevitable result that they had *scalped* upon coming into contact with the fire.

Crucibles respond so readily to proper treatment, that it is worth while emphasizing the few points that must be observed if the maximum service is to be obtained from graphite pots. The manufacturer is not infallible and occasionally a bad batch of pots slips through. However, the system under which he works, and the long years of practice in repeating the same operation, reduce the chance of mistakes on the part of the factory to the minimum. It is safe to say that 90 per cent of crucible failures are traceable directly to poor treatment on the part of the user.

The principal cause of the failure of crucibles is the lack of proper annealing. When a crucible comes from the kiln it contains but ¼ per cent of combined moisture, and in this condition it is impossible to scalp it. However, during transportation from manufacturer to user, a crucible, like salt, absorbs moisture from the atmosphere. A temperature of not less than 250 degrees Fahr. is required to dispel this moisture.

Most crucible troubles occur in small shops. The large consumers have found it well worth while to equip their plants with drying-ovens especially to dry and anneal their crucibles before they are put into the furnaces. Whether annealing in a special oven or on top of the crucible furnace, the following four points must be observed:

The temperature must go above 250 degrees Fahr.

The temperature should be reached gradually.

The temperature must be held a sufficient time to allow the moisture to thoroughly disappear.

The crucible must go into the fire with a temperature above 250 degrees Fahr.

It is a mistake to think that after the first three rules have been followed the crucible has had its annealing and is impervious to moisture. If allowed to cool below 250 degrees Fahr. it will again take up moisture as readily as the first time.

Use Care in Handling

Another enemy of the crucible is misshapen tongs. When the crucible is hot, it is in a somewhat plastic condition and is easily squeezed out of shape or ruptured. The best tongs are the basket variety which grab the crucible both below and above the bilge and hold it firmly without squeezing. It has been found good practice to have an iron crucible cast over which the tongs can be straightened and shaped at frequent intervals. This method is not only much quicker and simpler, but gives a better result than sending to a blacksmith. Some shops find it advisable to have tongs of two sizes; one for new crucibles and one for old pots, which are considerably smaller.

In using an oil-furnace, the flames should never be allowed to play directly on the crucible, as scoring will follow, and the crucible will soon wear through on that side. In addition, one side will heat faster than the other. Oil-furnaces giving a rotary flame, seem to be the more satisfactory and to give the most even heat on all sides of the crucible.

The use of wet coke is also bad practice because steam comes in contact with the crucible and forms checks known as alligator-cracks. These will likewise form when a crucible is exposed to the moist gases on top of the furnace, while it is being annealed. Therefore care should be taken when annealing a crucible on top of the furnace, to see that it is kept away from direct contact with the flame within.

The activities of the furnace-tender with his iron poker often shorten the life of the crucible. Many shops make a practice of keeping account of the number of melts each tender gets from a crucible so that the careless tender can be checked, and the average number of heats increased.

The number of heats from a crucible depends largely on the metal to be melted, and on the temperature required for the melt. A crucible that will last only three or four heats with nickel will last 25 heats with copper, and 40 or more with composition metal. If a flux is used, it lowers the life of the crucible by attacking the clay that holds the graphite together.

In general poor results are caused to a large extent by poor treatment. More attention to the details of storing and annealing the pots and to their treatment while in the furnace will pay large dividends in the increased service obtained.

Secures Foundry Contract

The Austin Co., Chicago, has secured the contract for a new foundry for the Bush-Sulzer Diesel Engine Co., St. Louis. This foundry will produce heavy and medium gray iron engine castings and will employ about 50 molders. The officers in charge are Max Rotter, vice president in charge of engineering; Oscar Pfeiffer, general superintendent; P. E. Arndt, purchasing agent, and Thomas Leisk, foundry superintendent.

Planning and Operating a Galvanizing Plant

Choice of Kettles, Acid Tanks and Cleaning Equipment Influences Successful Operation of a Hot Galvanizing Installation—Temperature Factors and Difficulties Analyzed

By E P Later

SAD experience teaches that iron which is exposed to air and moisture soon becomes corroded and in time will be completely destroyed. It ordinarily is necessary to apply a protective coating of some material such as paint or japan or a thin film of some other metal in order to preserve iron. What is known as hot-dip galvanizing is one of the most important and most widely used processes employed for protective coatings. In its bare essentials the process includes cleaning the parts thoroughly and immersing them for a short time in molten zinc, using certain cleaning agents or fluxes to insure the production of a good coating.

Points to Watch

This, however, is not quite so simple as it sounds and there are many points which must be watched closely. Considering for a moment the installation of a galvanizing plant, the selection of the best location is a matter which merits careful attention. Steam and unpleasant, corrosive fumes are produced and for this reason it is advisable to keep this department as far as possible from the rest of the factory. It should be in a small building by itself, if this arrangement is feasible. In any event ventilation should be thorough and it is well to cover the kettles and tanks with hoods, using an exhaust system or a stack to insure prompt and thorough removal of the fumes.

A quantity of water is used in a hot galvanizing plant and a plentiful supply should be available, together with ample sewer connections. Steam for heating some of the tanks usually will be needed.

The floor should be made of acid-proof brick or other material which is not affected by acid or water and if any other departments are situated below care should be taken to see that the floor is sufficiently tight to prevent leakage.

One of the main items of equipment is the kettle or container for the molten zinc and the size of this will naturally depend upon the amount and character of the work to be handled. A kettle approximately 3 inches long, 18 inches wide and 20 inches deep is about as small as can be operated with satisfaction, because of the difficulty in maintaining an even temperature in smaller kettles. A bath of smaller size would serve only for treating a small amount of work and as a matter of convenience the size recommended is better. In this connection it may be stated that a hot-dip galvanizing plant is an expensive affair at best and unless it is carefully managed and a considerable amount of work is done it will seldom be a paying proposition.

The best material to use for kettles has been studied for many years, but thus far the problems presented have not been solved. Glass and earthenware are about the only materials which are not attacked or dissolved by the molten zinc. Iron and all of the ordinary metals go into solution in it quite readily, but inasmuch as it would be impracticable to use glass or pottery wrought iron or mild steel kettles are ordinarily employed. From certain investigations it appears that pure iron kettles are less rapidly dissolved by the zinc, with the result that the useful life of the kettle is considerably increased.

Heating the Bath

Coal, oil, natural gas or coke may be used for heating the kettle, and the construction of the furnace will depend to some extent on the fuel employed. Coke is ordinarily preferred. There is a difference of opinion as to whether coke-fired furnaces are best constructed with or without grates. From my own experience I prefer to have grates for I have always felt that in a furnace without grates the draft coming directly onto the sides of the kettle tends to shorten its life. Aside from the question of design, however, skilful firing is an important factor in determining the life of a kettle; this point will be discussed later.

The parts to be galvanized must, of course, be thoroughly dry before they are immersed in the molten metal. This drying may be accomplished either by providing an oven or plate heated by a small, separate furnace, or by the waste heat from the galvanizing furnace.

The tools used in galvanizing are simple, comprising various sizes of perforated iron buckets for holding small articles during immersion, one or two hoe-shaped skimmers, a large, perforated shovel for removing the dross from the kettle, tongs and other implements that the character of the work may demand or the ingenuity of the galvanizer may suggest.

Several acid and water tanks will be required, the number and size depending on the number and size of the parts treated. Water tanks are frequently made of sheet iron and under ordinary conditions these will last for a long time. They would not, of course, be suitable for acid pickles. For these earthenware or wooden tanks must be employed. The former material is not attacked by any of the ordinary acids excepting hydrofluoric, but the weight and fragility of such vessels constitute a serious disadvantage to their use. Wooden tanks made of cypress, pine or other suitable wood are generally employed.

It is best to assemble acid tanks with copper rods and bolts, rather than iron, for the reason that iron is readily attacked even by dilute acids and parts made from it may be destroyed in a comparatively short time, putting the tank out of commission.

Tanks used for cold acid solutions can with advantage be coated on the inside with asphaltum or similar material, in order to protect the wood from the action of the acid. Heavy boards over the sides and bottom, on the inside, keep the tank from being injured when heavy parts are dropped in or taken out. For small establishments oil barrels sawed in halves make cheap and fairly serviceable tanks and may often be used to advantage.

Starting a New Kettle

Starting a new kettle is a rather serious matter, for unless a good deal of care and skill are exercised it is easy to ruin the kettle from too rapid firing. Before firing, enough lead should be put into the kettle to give a depth of 6 or 8 inches, depending on the size. Zinc slabs should then be piled up on edge along the sides, practically covering the exposed surfaces. As the outer slabs melt those in the middle will be pushed more or less closely against the sides of the kettle and the danger from over-

heating will be greatly lessened. The time required to melt the zinc in a good-sized kettle should not be less than 36 hours and may take longer. It should always be remembered that any attempt to hurry the process is likely to result in a damaged or ruined kettle.

In plants where there is more than one kettle filling a new one is considerably simplified for the reason that molten zinc can be taken out of the old one, the amount removed later being made up by the addition of new metal. Before using the bath a small amount of aluminum or special alloy is usually added to the zinc to improve the appearance of the finished work.

Care in firing is not confined to the melting of the zinc for the first time. Close temperature control is a factor of prime importance not only in the matter of producing good work, but in determining the length of life of the kettle. The size of the parts treated governs to a considerable extent the temperature to be maintained. Contrary to what might be expected, large, heavy parts require a comparatively low temperature; smaller parts, of a size suitable for stringing on wires, need a higher degree of heat, while parts which are best galvanized in baskets may require a still higher temperature.

Finding the Best Temperature

More specifically, 800 degrees Fahr. is about the right temperature for galvanizing large gray iron castings. At this point the metal will be sufficiently liquid to flow easily and will be of a silvery white color, and when skimmed the thin coating of oxide will be slow in appearing.

For galvanizing heavy malleable iron castings, wrought iron pipe and, in general, medium-sized parts, a temperature of about 850 degrees Fahr. will be found suitable. Under these conditions the surface of the zinc will appear slightly bluish and show a coating of oxide a few seconds after being skimmed. Sal ammoniac thrown upon the metal will be vaporized fairly rapidly.

Small work, such as is done in baskets, sheet steel, etc., requires a temperature around 900 degrees Fahr. This degree of heat will cause the zinc to appear distinctly blue, oxide will form at once after the metal is skimmed and sal ammoniac will be quickly vaporized.

It should be understood that these figures are only approximate, for it is difficult to specify the temperature which should be used for any particular kind of work. One must always be guided by the appearance of the coating, in determining the temperature to be maintained and in addition there are a number of factors which make it unwise to go by any arbitrary rule. For instance, baths which have been overheated or contain considerable amounts of iron or which have been made up from inferior grades of spelter will not work the same at any given temperature as a new or carefully handled bath made up of high grade metal.

Human Equation Important

Instruments for measuring the temperature of the bath are a practical necessity, but after all the experience and skill of the galvanizer must play a large part in the control of the temperature This is particularly true when work of widely varying size is being treated. Perhaps the greatest value of instruments of this sort lies in enabling the workmen to keep the temperature constant, when the parts treated are of fairly uniform size and character, and in giving the watchman or other attendant some guide to go by in firing the kettle at night and during other periods when the plant is not in operation.

For indicating the temperature either a suitable thermometer or a good pyrometer may be used and will give satisfactory service, provided, of course, that they have been correctly calibrated. Pyrometers, in particular, undergo a certain amount of deterioration after long use and it is advisable to check them occasionally, in order to be sure that they are working properly.

The life of a galvanizing kettle is uncertain. I have known at least one to fail after one week's use, while others have lasted a year or more. No doubt much depends on the material of which it is constructed, but the care exercised in firing and the frequency of drossing are more important factors in determining the length of service. The molten zinc slowly, but constantly eats away the sides of the kettle and inasmuch as the rate of solution increases with the temperature it can be seen that it is advisable to keep the heat down as low as is consistent with the production of good work. A high temperature, maintained either through carelessness or necessity, always means a shortened life for the kettle.

Under normal conditions of operation the molten zinc soon comes to contain considerable amounts of iron, dissolved from the kettle and the parts which are being galvanized, and this makes it pasty and sluggish. In order to overcome this the temperatures may be raised—with the result that the kettle may be burned out long before its time. The real cure is frequent and thorough drossing, removal of the zinc-iron alloy which slowly separates out of the zinc onto the lead in the bottom of the kettle. It is a pasty mass and may easily be removed by means of a perforated shovel which, in the case of large kettles, is usually handled by a crane.

Coming now to the operations of the galvanizing process itself it may be said that most of the secret of producing good galvanized work lies in the careful and thorough preparation of the parts. Sheet steel and wrought iron parts, pipe, forgings, castings all have a certain amount of rust, scale, oxide and the like which must be removed. The procedure to be followed depends to a certain extent on the character and size of the work.

Pickling in acid is a simple process which can be used with practically any kind of parts and finds wide employment. The oxide on sheet steel and similar material can easily be removed by immersion in a bath of sulphuric acid. The strength of acid employed varies from about 4 per cent to 8 per cent and it is customary to use the solution hot. However, the mistake should not be made of heating acid pickles to the boiling point as it does little good and causes loss of acid. A temperature of 150 to 180 degrees Fahr. is sufficiently high. Pickling, it should be remembered, is a process which requires careful attention. It is easy to let the action go too far, with the production of a scarred, rough surface and consequent waste of acid and time. Agitation of the parts while they are in the acid is to be strongly recommended, as it will do much in the way of saving acid, shortening the time and preventing over-pickling or under-pickling of some parts.

Avoiding Patches

Patches are often found on sheet steel and forged work where the oxide is thick and strongly adherent and it is much better to loosen the oxide in such spots with a chisel or sharp tool, rather than to allow the parts to remain in the acid until the entire surface is clean. Under the latter circumstances over-pickling of the greater part of the surface is certain to result.

After the work has been thoroughly cleaned in the pickle it should be removed and, if it is desired to keep it for a time before galvanizing, it may be placed in a tank containing enough clean water to cover it completely. This will prevent rust. If, however, the parts are to be finished at once they should be rinsed and then dipped in muriatic acid. The strength of acid

used varies somewhat, but equal parts of acid and water will work satisfactorily. After immersion in this bath, the parts should not be rinsed, but should be placed in the drying oven or on the hot plate and allowed to become thoroughly dry. The acid leaves on the surface a coating which is necessary to enable the zinc to unite properly with the iron and in drying the work care should be taken not to burn the coating, either by heating to too high a temperature or for too long a time.

Cleaning Castings

Cleaning castings is a somewhat different proposition and while it is not particularly difficult to put the surface in the proper condition to take the zinc, trouble is often experienced in obtaining a satisfactory finish on such parts. This usually can be traced to careless or improper preparation before galvanizing. Ordinarily, there is sand and scale to be removed and one of the oldest and simplest methods of doing this consists in placing the castings on an inclined platform and pouring over them frequently a dilute solution of sulphuric acid. A suitable tank should be placed at the lower end of the platform to catch the acid which drains from the castings. Sand is not attacked chemically by sulphuric acid, but this dissolves the iron from under and around the sand, which then falls off.

One objection to pickling castings in sulphuric acid is that if the action is continued too long the surface becomes covered with a gummy, slimy coating which seriously interferes with galvanizing. When such a coating is found to be present the castings should be immersed for a few minutes in a strong, boiling solution of caustic soda.

In recent years hydrofluoric acid has come into wide favor for pickling castings, for the reason that it removes sand by dissolving it, but does not seriously attack the iron. Consequently there is little danger of over-pickling. A solution of one part acid to 10 or 20 parts water will be found satisfactory for most purposes. This should preferably be used cold, allowing the parts to remain in it as long as necessary. Warming the solution does no harm, but it should not be used hot. For quick pickling a bath composed of four parts muriatic acid, six parts hydrofluoric acid and 40 parts water has been recommended. Incidentally, hydrofluoric acid is very poisonous and care should be taken to avoid inhaling the fumes given off from the bath.

In several ways sandblasting and tumbling, mechanical methods of cleaning castings, offer advantages and will in most cases merit serious consideration. Little need be said, however, regarding the design and operation of sandblasting machines and tumbling barrels, as these are familiar.

Dry tumbling, wherein the parts are tumbled with stars or shot, has been used for many years as a means of knocking off sand and scale and producing a more or less bright and smooth finish. When properly carried out on castings and other parts which are of a size and shape to permit such treatment little pickling will be necessary before galvanizing, while the smooth surface produced improves the appearance of the zinc coating.

In loading a tumbling barrel, a layer of shot should be put in first, followed by a layer of castings, then more shot and so on until the barrel is nearly full. The proportion by bulk of shot to castings will naturally vary according to the character of the latter, but 1/3 shot to 2/3 castings is about right for ordinary work. If the barrel is too full there will not be enough room for the movement and consequent cleaning friction of the parts on each other. On the other hand, leaving too much room may result in the breaking of fragile castings.

Whatever method of cleaning is employed, at its conclusion, the parts should be free from sand, scale and all foreign matter. It is good economy to inspect all work at this stage in order that any pieces which have not been properly prepared may be detected and sent back for further treatment. Inspection should take place as soon as possible after cleaning in order to prevent rusting. The parts should then be dipped in muriatic acid and, without rinsing, dried on the hot plate.

Coating With Zinc

The next operation is immersion in the molten zinc, but before any work is galvanized the surface of the zinc should be partly covered with flux. This is made by scattering a few handsful of sal ammoniac on the molten metal and when the salt has melted a small amount of glycerine should be added to it; a few drops will ordinarily be enough. The office of the flux is to facilitate the formation of a smooth, even coat of zinc on the work and, in addition, to lessen the oxidation of the molten metal. Fresh sal ammoniac should be added from time to time as needed.

The exact manipulation during immersion varies somewhat with the character of the parts. In general, small parts are treated in perforated iron baskets. The flux should be fairly liquid and the basket filled with work lowered through it into the zinc, which should be at the proper temperature. In a few moments the parts will reach the same temperature as the bath and, after washing them around in the metal, a clear space should be skimmed on the surface of the zinc and the basket withdrawn. If the parts do not take the coating well it will be necessary to pass them through the flux again, or to sprinkle a little sal ammoniac over them, shaking meanwhile, and immerse.

If the coating appears to be satisfactory the basket should be jounced up and down for a few seconds over the kettle in order to remove the excess of zinc. The parts may then be dumped into water to cool and afterward dried by dipping into hot water and tumbling in sawdust. Usually a small amount of mineral oil, just enough to produce a thin film, is poured into the tank containing the water used for cooling.

Handling Small Parts

Many parts can be handled to the best advantage by stringing them on heavy iron wires. When as many pieces as desirable have been strung on such a piece the ends should be tightly twisted or clinched and the wire hung on an iron bar with a hook at one end, for immersion in the zinc. After the parts are coated they should be withdrawn and shaken to clean off the excess of metal and prevent sticking together when they are thrown into water.

Larger castings should be held by tongs and passed through the flux into the zinc. After the part has reached the temperature of the bath a clear space is skimmed on the zinc and a little sal ammoniac sprinkled on; then the casting should be slowly withdrawn and, before it is entirely out of the zinc, grasped with another pair of tongs and allowed to drip. As the last drop or two starts to harden it should be brushed off, thus making a smooth job. As a rule castings with thin sections should not be plunged directly into water after removing from the zinc, but should be allowed to cool until crystals appear and then gone over lightly with a wet brush; otherwise they are liable to be broken by the sudden contraction incident to contact with the cold water. Heavy castings, on the other hand, may be allowed to drip and cool for a moment and then dumped into water.

Briggs & Turivas ,Chicago, dealers in iron and steel scrap, have opened a New York office in the Equitable building, under the direction of the president, Carl R. Briggs.

Form 316

PATTERN TRANSFER

PATTERN STORAGE TO SKETCH ROOM

Date J. No Ord. No.

Cust. Cust. No.

Pattern No. Storage Section Shelf

Description Quan. Req'd

Pattern Checked Promised for Steel Carbon

No. Core Boxes Classification

Estimated Weight

Flask Size Estimated Time

REMARKS

FIG. 1

Form 316

STICKER

Date J. No. Ord. No.

Cust. Cust. No.

Pattern No Storage Section Shelf

Description Quan. Req'd

Pattern Checked Promised for Steel Carbon

No. Core Boxes Classification

FIG. 2

Form 316

PATTERN TRANSFER

FOUNDRY TO PATTERN STORAGE

Date J. No. Ord. No.

Cust. Cust. No.

Pattern No. Storage Section Shelf

Description Quan. Req'd

Pattern Checked Promised for Steel Carbon

No. Core Boxes Classification

Estimated Weight

Flask Size Estimated Time

REMARKS

FIG. 4

Form 316

MOLD CARD

Date J. No Ord. No.

Cust. Cust. No.

Pattern No Storage Section Shelf

Description Quan. Req'd

Pattern Checked Promised for Steel Carbon

No. Core Boxes Classification

Estimated Weight

Flask Size Estimated Time

Date	Man No	Tag No	No. Pieces	Finish	Start	Time

Delays

Foreman

FIG. 3

Form 316

PATTERN TRANSFER RECORD

Date J. No. Ord. No.

Cust. Cust. No.

Pattern No Storage Section Shelf

Description Quan. Req'd

Pattern Checked Promised for Steel Carbon

No. Core Boxes Classification

Estimated Weight

Flask Size Estimated Time

Patt. Storage to Sketch Room		
Stickered and Active		
Active Floor to Foundry		
Foundry to Patt Storage		

PATTERN TO WORK

Job No	Promised for	Job No.	Promised for

FIG. 5

FIG. 1—PINK PATTERN-TRANSFER CARD WHICH ROUTES PATTERN OUT OF MAIN STORAGE. FIG. 2—STICKER PLACED ON PATTERN WHEN IT GOES INTO THE FOUNDRY. FIG. 3—MOLD CARD, YELLOW. FIG. 4—GREEN PATTERN-TRANSFER WHICH MOVES PATTERN BACK TO STORAGE. FIG. 5—PATTERN-TRANSFER RECORD SHEET WHICH IS KEPT IN CONTROL DESK

A Simple Pattern Control and Routing System

Description of Method Worked Out at an Ohio Steel Foundry

Based on Five Standard Forms Operated from Central Office

SYSTEM is essential in every undertaking and every business in which production details are handled has some kind of a working plan even though in many instances it is hidden and difficult for anyone to see or decipher. In other cases, such elaborate methods are employed for controlling routine operations that they stand out above all other features of the business, and the organization seems to exist for the system instead of the system being the servant of the organization. Such a superabundance of regulation is proverbially known as red tape, and these words have been so frequently used in a condemnatory sense that even the neophyte is aware they carry a vigorous warning against methods in which the means become more important than the end. So, in installing a system, the first thing to do is to draft some procedure which will direct the course of the work without confusion, and the second is to avoid as many complications as possible.

The more numerous and varied the operations which must be directed and controlled, the more detailed the method of taking care of them will tend to be. For this reason, plans adopted for following patterns through the foundry—for getting them ready with their core boxes; seeing that they reach their proper places at the right times; assembling the cores at the molds and returning the patterns and core boxes to their shelves in the pattern storage when the order is completed—are frequently inadequate or too elaborate.

A pattern-control system in which an effort has been made to keep on proper middle ground, avoiding unnecessary red-tape, yet furnishing adequate information at every stage of the work has been devised by the Canton Steel Foundry Co., Canton, O. This system was worked out to meet conditions which arose about three years ago when the Canton plant was reorganized. Soon after the new management took hold an increased volume of business was obtained. This in turn created a need for a more satisfactory method of routing patterns through the foundry and back to storage, in order to avoid embarrassing delays and confusion at various stages in the production process. The experience and ingenuity of everyone interested in the work was brought to bear on the problem, and with the help of a suggestion from one person and a criticism from another, the plan to be described in this article was worked out under the supervision of W. D. Jones.

The outlines of this system were briefly delineated in an article in the preceding issue of THE FOUNDRY describing the plant of the Canton Steel Foundry Co. As was mentioned in this article, the Canton pattern-control method centers largely around a set of five standard forms to which each customer's order is transferred as soon as it is received by the production department. Adjacent to the production office is a control office where the records of work going through the shop are kept and the foundry's efforts guided by means of entries on the standard forms. A pattern-checking room and live pattern-storage department, conveni-

FIG. 6—THE CONTROL CLERK AT WORK AT HIS DESK IN THE CONTROL ROOM—HERE THE RECORDS SHOWING THE STATUS OF EVERY ORDER IN THE FOUNDRY ARE INSTANTLY AVAILABLE

FIG. 7—MAIN PATTERN-STORAGE SHOWING ARRANGEMENT OF AISLES AND NUMBERING SYSTEM

ently located alongside the control and production offices, form another link in the chain. Every pattern on its way from storage to the molding floor passes through this department, where its condition and measurements are checked and where if necessary it is sketched in order to facilitate the solution of molding problems or to straighten out other kinks. The sketch also constitutes a record in case anything happens to the pattern. This checking feature avoids considerable trouble and delay in the foundry.

The Heart of the System

The heart of this system, however, is in the control room where complete data on all live orders are kept in a specially designed desk, and from which central station every job is routed by the control clerk and by him speeded up or retarded in favor of other more important work as the case may be.

The operation of the system is under the control of the production manager, who in addition to the necessary labor, is provided with a main pattern-storage boss, a control clerk, a pattern checker, job chasers, and foundry clerks. Each of these men have special functions which will be described later.

The five standard forms are shown in Figs. 1 to 5, inclusive. Each one has its particular duty to perform and carries on its face all the information needed to enable it to fulfill its purpose. At the same time it is not burdened with unnecessary instructions or data. Of the five different forms used, two are on white paper and three are on cards of different colors. They are put up in proper order, in pads printed four to a sheet, and perforated so they readily may be torn apart. Whenever an order is received in the production department, Fig. 11, the first sheet, marked *sticker*, is torn off the pad and filled out on a typewriter using hectograph ribbon. After four orders are recorded the sheet is complete and is then used as a master copy for hectographing the other four sheets. The forms are next detached at the perforations and the five belonging to each order are put together and sent to the control clerk in the room shown in Fig. 6. This room is located across the hall from the production office. Here the filled-in forms are placed in the active files contained in the special desk previously mentioned. This desk was made by the McCaskey Register Co., Alliance, O. The active orders are kept in compartments on the top of the desk and are arranged according to order numbers, their location being identified by the markers which can be seen in Fig. 10 attached to each leaf in the folder. A roll-top is provided for every one of the six sections into which the desk is divided so that they may be closed and locked at night. In the same room a file giving the location of the patterns in storage is kept. The illustration shows this file in the rear of the room near a telephone which is provided for the convenience of the clerk, as information regarding patterns must frequently be given to different departments. The lower part of the McCaskey desk is provided with drawers which are used to preserve the records covering completed work. These drawers have sufficient capacity to hold the records for 3000 orders.

Plenty of Information

When the set of forms is received in the control department each sheet has on it the date the order was entered, the job number, the order number, the customer's name and order number, the pattern number and location of the pattern in storage, a description of the pattern and cores, the quantity required, the date for which the castings are promised, the number of core boxes, and the classification of the job. Either the grade of steel from which the castings are to be made is given by num-

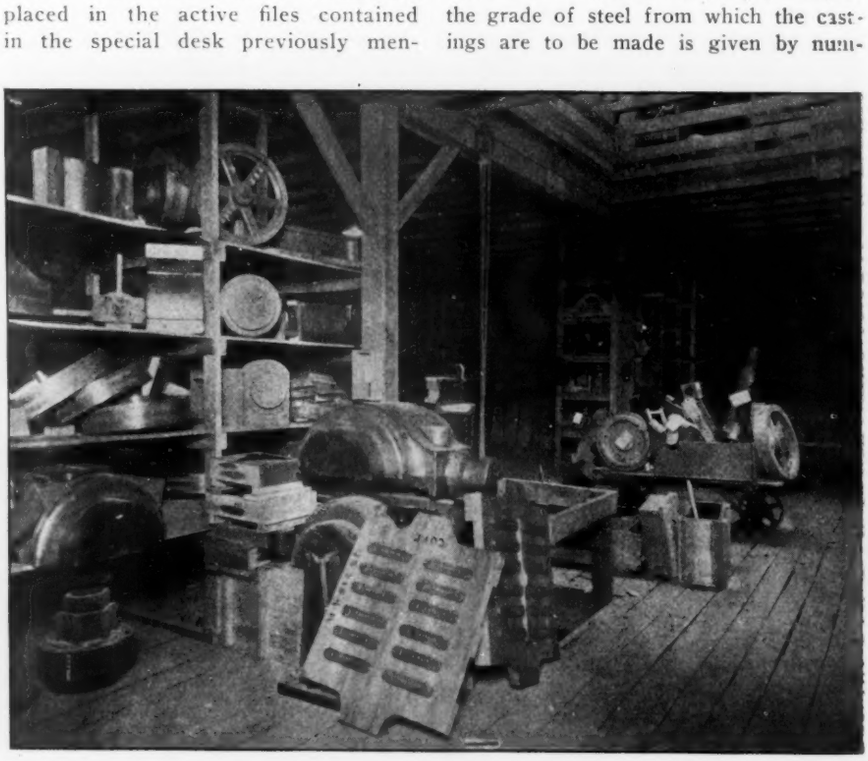

FIG. 8—LIVE PATTERN-STORAGE NEXT TO CHECKING ROOM, THROUGH WHICH PATTERNS PASS ON THEIR WAY TO THE FOUNDRY

ber, or the carbon contents are specified.

The first card sent out is the pink one marked *pattern transfer,* Fig. 1. It is delivered to the man in charge of the main pattern-storage lofts. One of these is shown in Fig. 7 which also indicates how the different aisles are numbered and the patterns piled. The pink card is a notice to the pattern-storage foreman to send the pattern to live storage adjacent to the checking or sketching room, which he does, tacking the pink *pattern transfer* card to it. When the checker receives the pattern he fills out the pink slip with the estimated weight of the casting and the flask size, and sends it back to the control clerk who puts on it the estimated time required to execute the work. The control clerk then gives the slip to the job chaser who files it according to promise date and uses it for his information in following up the job. When the work is complete the card has served its purpose and is thrown away.

The receipt of the *pattern transfer* card by the control clerk is a notice to him that the pattern is in the checking room. He then marks the date promised on the *sticker,* Fig. 2, which is forwarded to the checker who pastes it on the pattern, shellacing it over to protect it.

The pattern is now shipped to the foundry floor where the molds for this particular job are to be made. The live storage where the patterns are held temporarily while awaiting assignment to the foundry, is seen in Fig. 8, in the background of which is a truckload of patterns. These have just been received from the main storage and still have the pink *pattern transfer* tickets attached to them. The checking room and the control room are adjoining each other and both open into the live-storage. This has proved a very convenient arrangement as it is necessary for these departments to be in constant communication with each other.

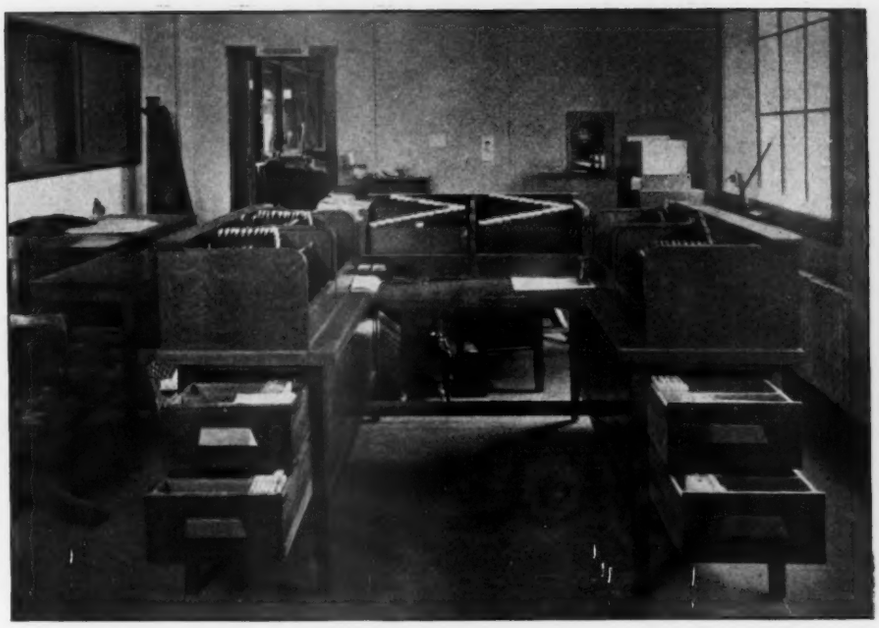

FIG. 10—DETAIL VIEW OF THE CONTROL DESK SHOWING FILING SYSTEM

Where the Molder Comes In

At the same time the *sticker* is sent out, the yellow *mold card,* Fig. 3, is forwarded to the foundry clerk. It acts as a warning to him to watch for the arrival of the pattern on the molding floor and also furnishes all the information about the job which the foundry requires. As soon as the pattern is received by the foundry it is checked by the clerk and the work is assigned to the molder by the foreman of the floor where the pattern was received.

The *mold card* is then filled out with the date, the molder's number and tag number and filed in the foundry office according to the molder's number. Here it serves as a time card, being provided with columns for recording the number of pieces cast, the time of starting and finishing work, and the total time charged each day. When the job is completed the *mold card* is returned to the control clerk who then sends to the foundry the green *pattern transfer* ticket, Fig. 4. It constitutes an order to return the pattern to the main storage where the green ticket is removed and destroyed, marking the completion of the order.

All the while the different cards are traveling around the shop the *pattern transfer record* sheet of white paper, Fig. 5, is in the active file of the control clerk. On it are recorded all the different moves of the pattern—first the date it was ordered from the main storage and arrived in the active pattern storage, the day it went to the foundry, and finally the date it left the foundry and was sent back to the pattern storage.

At the bottom of the *pattern transfer record* is a form for use when more than one order is to be made from the same pattern. This form consists of columns for noting the job numbers and the dates on which the castings are to be furnished. This short cut saves the extra moves which would be involved in returning the pattern to the

FIG. 9—PATTERN CHECKER AT WORK IN THE PATTERN-CHECKING AND SKETCHING ROOM

FIG. 11—THE PRODUCTION OFFICE WHERE ORDERS ARE ENTERED AND TRANSFERRED TO THE STANDARD FORMS

main pattern-storage after the completion of each order, followed by the issuance of new instructions to get it back into the foundry. Instead, all that is necessary to issue a *mold card* for each order and the pattern stays in the foundry until the work is completed.

In studying this system it will be noted that the man in the control room has continuously before him the record of every active job, through the method of filing by order number and the convenience afforded by the specially designed desk. Also, when this clerk refers to his records he can tell exactly what state the work is in, because every operation is subject to his authority. Each step taken in the execution of the order is dependent upon the control clerk's being informed that the previous operation has been satisfactorily completed.

Americanizes Iron Works

At the recent general meeting of the German Iron Founders' association held in Berlin, the opinion was expressed, and generally approved, that only by Americanizing the German iron industry, that is to say, by concentrating it in a few large works, can it be made capable of surmounting the difficulties of the changed circumstances, the radically altered conditions, into which it is coming. American experience has shown that in concentration there is strength to resist and power to compel. All forms of industry are tending to concentrate themselves in large works.

Pure Water Corrodes Nonferrous Castings

THE fourth report of the corrosion committee of the British Institute of Metals, recently issued, treats of the nature of the action that occurs when such metals as zinc, copper and brass of the composition, copper 70 per cent and zinc 30 per cent, are exposed to the corrosive action of a neutral liquid, such as distilled water, and a nearly neutral liquid such as sea water, with special reference to the behavior of condenser tubes.

In the case of zinc, when exposed to distilled water the following conclusions have been arrived at: Metallic zinc is normally covered by a scale composed largely of zinc oxides or basic carbonate which partially protects the metal from corrosion. Water containing gases such as carbon dioxide, the gas present in carbonated waters and many mineral springs, is able to dissolve this protecting scale, thus exposing the metallic zinc to the action of the water. Under these conditions the zinc is dissolved to a certain extent with the formation of a slightly soluble bicarbonate, and a peculiar kind of oxide which is not soluble but which, together with the excess bicarbonate, is precipitated on the zinc. This forms a coating which protects the zinc from further action, unless the water is so agitated that the corrosion products are prevented from settling and covering the metal surfaces. This action is spotty or local in character. From the results of the investigation it was concluded that the action of distilled water on zinc is one of chemical oxidation rather than one of electro-chemical action. In the case of copper, the action is also one of chemical oxidation. The oxides formed on the surface of the copper are low oxides consisting either of four atoms of copper to one of oxygen, or of two atoms of copper to one of oxygen. This oxidization continues in spots and forms little bubbles which flake off and in time cause shallow pits in the metal, which, however, are not so important as in the case of zinc. This pitting action does not always occur in the case of copper, as occasionally the surface of this metal is uniformly oxidized.

On a brass of the composition, copper, 70 per cent and zinc 30 per cent, the action of distilled water on zinc considered one of chemical oxidation; in this case of both the copper and the zinc, and it carbon dioxide is present most of the zinc is soluble in the water, also part of the copper, and the undissolved portions of both metals remain on the surface of the brass in the form of an oxide scale. This scale gets thicker with time and being porous fails to protect the underlying metal from further action, with the result that the general surface of the alloy becomes completely corroded and at the same time a part of the copper is redeposited electro-chemically or otherwise. From analytical data it would appear that in time the corrosion ceases to proceed uniformly.

The action of sea water on all these metals is similar in character to that of distilled water. The action of acids is more uniform than that of water, as the zinc is taken up by the solution and there are local accumulations of the products of corrosion which protect the underlying metal or affect the character of the corrosion. Dilute hydrochloric and sulphuric acids, have on brass a similar action to that of acetic acid on zinc. The strength of the dilute acid solutions that were used in the tests, was between 5 to 10 parts of acid in 100,000 parts of water, approximating the composition of some of the slightly acid natural waters.

Making Castings Used in Ship Construction—II

Detailed Methods of Molding are Outlined and the Difficulties Encountered Are Described—Ramming, Setting, and Pouring Basins are Discussed

By Ben Shaw and James Edgar

THE principles involved in preparing molds to receive molten steel, in many respects, are similar to those which characterize the preparation of molds for cast iron, but in practice the peculiar nature of the metal necessitates special provisions for overcoming many difficulties encountered and not common to gray iron work. The sand is rammed very hard, in fact it cannot be rammed too hard, but the facing comprising the mold consists of a different mixture than that used for iron. Owing to the higher temperature of the metal, sand, or a composition of high refractoriness must be used and the need for this is intensified with the increase in thickness of metal with which it comes into contact.

To meet demand for a special composition of this kind many firms in England supply what is termed *composite* and it is suggested for the benefit of those iron foundries where an effort is being made to assist in coping with the greater demand for steel castings for ships, to make use of these compositions unless, of course, there is ample material at hand from which a good mixture can be milled.

In English steel foundries a good composition is made from broken crucible pots from which the flux has been freed, burnt ganister or any other highly refractory material which has been in use in coke furnaces, old refractory bricks, clay from slate quarries and hard foundry coke; all of this is ground together in varying proportions, depending upon the degree of refractoriness required, and water is added to make it more cohesive. The loam used in steel foundries is of a similar composition, but contains more water, it being mixed to a consistency resembling that of lime. In appearance, the mixture is not unlike fireclay, only coarser. Like the facing used for iron castings, once it has been in contact with the molten steel it is no longer serviceable.

Bedding-in the Pattern

With the exception of large, unwieldy castings, the majority of molds are made in flasks, this method being adopted because of convenience in ramming and also to render the drying of the mold comparatively easy. In many small steel foundries, however, where larger work is being undertaken than anticipated when the plant was built, difficulties sometimes present themselves in rolling-over the flasks. Under such circumstances it becomes imperative to bed the pattern in the foundry floor or in a flask. The latter method is illustrated in Fig. 1, in connection with the molding of a rudder. It will be noted that a couple of wood straight edges are screwed to the bottom half of the pattern and rest on the surface of the drag flask. When this bedding-in process is adopted for large, flat work of this kind, it is advisable to leave the pattern as open as possible, consistent with rigidity, to give the molder easy access for ramming. To bed-in successfully requires considerable care and patience. The procedure is similar to that followed in bedding-in for cast iron work. The flask is rammed with ordinary floor sand until an impression can be made with the pattern; when the pattern is lifted out, some of this filler sand is removed from the impression thus formed, the amount varying con-

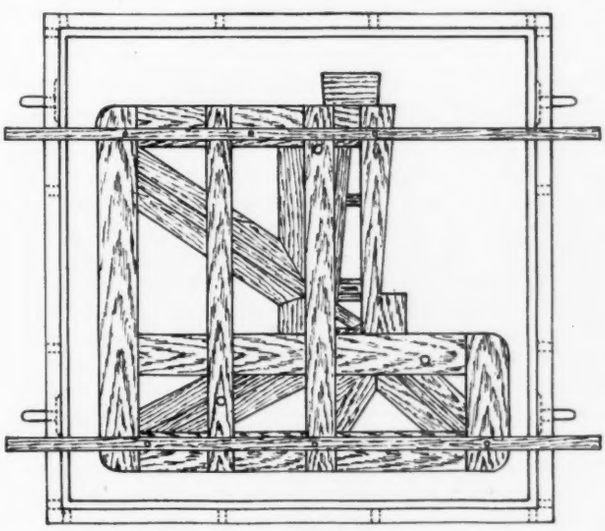

FIG. 1

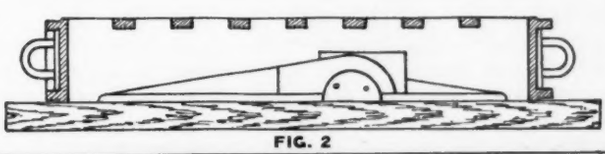

FIG. 2

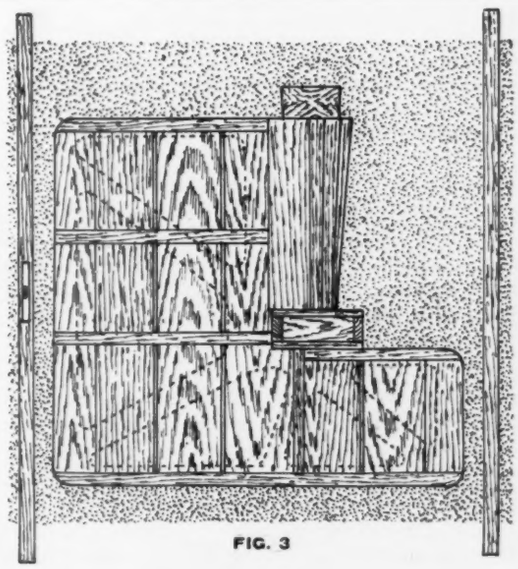

FIG. 3

FIG. 4

FIG. 1—THIS SHOWS THE PRELIMINARY STEPS FOR BEDDING-IN THE PATTERN AND FIG. 2 IS A SECTION OF THE DRAG HALF OF THE MOLD. IN FIG. 3 THE BED IS SHOWN WITH HALF OF THE PATTERN SET AND THE METHOD OF LEVELING THE BED IS ILLUSTRATED IN FIG. 4

siderably with the thickness of the composite required to take its place. In this instance it is about 1½ inches thick in some parts and increases to about 3 inches for the heaviest parts of the casting. It is safer to have too much composite than too little. When this has been done and the composite facing has been applied, the pattern is again used in securing an impression, pressure being applied in forcing it down until the straight edges or battens find a bearing on the flask sides. Finally, when the means of the level and a straight edge determine their relative position. When the pieces have been set and sand rammed around them, the whole bed can be prepared; it is preferable to ram fairly hard to reduce the labor required in making the joint. The bottom half of the pattern then is laid in position, the timbers removed and their impression is filled up. The bed is dusted carefully with parting sand and the flask is lowered. It is customary, when molding by this method, to employ wedging it against the flask, prevent the possibility of the pattern falling out while being rolled over.

After rolling-over the flask the top half of the pattern is lowered into position. The cope flask then is set in place, its relation to the drag flask being determined by pins. Gate sticks then are placed, their position depending upon the method of casting, whether vertically, horizontally or on an incline. To cast the rudder horizontally, two gates would suffice, each about 3 inches

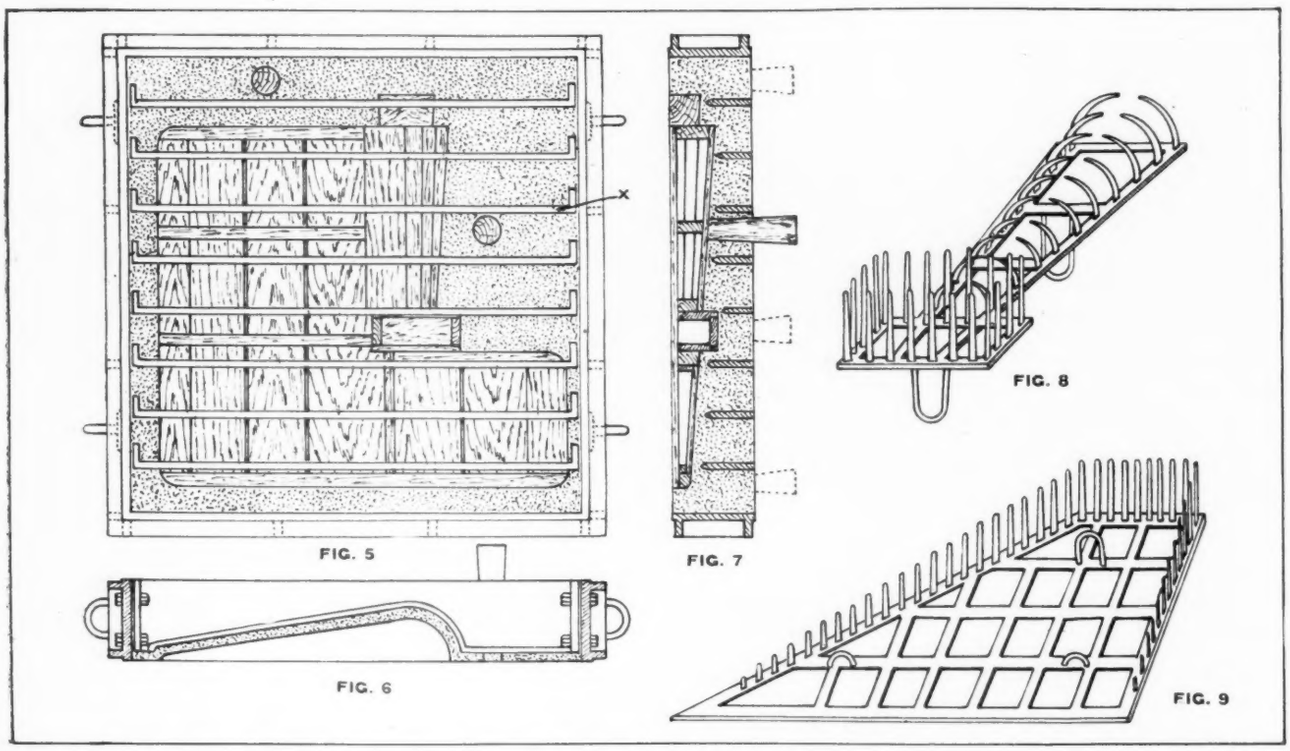

FIG. 5—THIS IS A PLAN VIEW OF THE COPE FLASK READY FOR RAMMING AND ONE OF THE BARS AT THE POINT X FIG. 5 IS ILLUSTRATED IN FIG. 6. A CROSS-SECTION VIEW OF FIG. 5 IS ILLUSTRATED IN FIG. 7 SHOWING THE LOCATION OF THE GATES AND RISERS. TYPES OF GRIDS EMPLOYED ARE SHOWN IN FIGS. 8 AND 9. THE GRID IN FIG. 8 IS USED FOR MAKING THE POST CORE

pattern is bedded-in, the remainder of the mold is rammed until the joint is reached, when the battens are removed and preparations are made to receive the top half of pattern and flask. A section of the drag showing the battens is shown in Fig. 2. The flasks used in many foundries are bolted together and slot holes are cast in the joint flanges for securing the parts together when casting. A number of holes also are cast in the sides so that loose bars can be made to accommodate the work for which the flasks are suitable.

The bedding-in method of molding is illustrated in Figs. 1 and 2. This is accomplished by making a level bed in the foundry floor, as shown in Figs. 3 and 4. It is not essential that the bed should be level, but it is necessary that it should be straight, hence the simplest way is to make it level by bedding into the sand floor a couple of straight-edge timbers, using a level while setting them, as in Fig. 3, and by flask bars similar to those used for the cope, but care must be taken to insure freedom for whatever runners may be required. Ordinary single bars may be used having flanges at each end, as illustrated in Fig. 5, or double bars may be bolted in. In the latter case the ends of the flask become the flanges and hence the same number of bolts are required to secure the two bars as would be necessary for each of the single bars shown in the illustration. In Fig. 3, the dotted lines represent the position of the prints. It is apparent that when a bed is made in this way and the flask is rammed in an upside down position, a more uniform density of sand is obtained and the facing sand can be regulated in depth much more easily. When the flask has been rammed, it is rolled over. In this case, where the weight of the pattern is considerable and the depth not great, it is advisable to set into the pattern a few screw eyes, and by passing a bar through them and in diameter. In some foundries, runners suitable for various sized castings are carried in stock and set into position while the work of ramming is proceeding. These are in the form of blocks, composed of ganister and firebrick, and are capable of withstanding the heat of the molten metal for a longer period than if formed from the ordinary composite mixture. Risers should be carried off at the high points, with special attention to those parts consisting of a heavier body of metal. In this case the metal surrounding the high points is very thick, hence, it is wise to lead off a substantial riser, thus allowing the casting to draw upon the riser at that point rather than the arms or ribs connecting it with the outside framework.

Then proceed to ram the cope flask in a manner similar to that followed in ramming the drag. Fig. 6 shows a section of the top of the mold and illustrates the approximate relation of one of the flask bars to the mold. Fig.

7 is a section through the center in line with the vertical center of the rudder post showing gates and risers. When the job has been rammed, the gate sticks are withdrawn and the cope is lifted. It is again necessary to provide for retaining the half pattern in the cope mold, so that a better lift may be insured when the flask is rolled over. Swab the joints and sleek-off, marking out the position and number of the runners required. In sleeking the joints it is safe to cut away or compress the sand on the edges of the pattern, so that a substantial fin will be formed on the casting, providing a cleaner edge and an escape for the gases. Draw the pattern and clean up in a manner similar to that adopted for a dry sand mold to receive cast iron.

To stiffen the body of the mold, be unsparing with 3 or 4-inch nails, more especially around the edges which form definite corners in the sand. In the body of the mold surrounding the thicker portions of the metal, a number of prod holes are often inserted having a diameter of about ½-inch and about 2 inches deep. These prods or dabbers afford a means of escape for gases which otherwise may be unable to find an exit. The mold then is thoroughly dried. If a portion of the mold has been formed in the foundry floor, fires must be arranged to dry it in place, supporting the cope over it and sealing the sides with plates as much as possible. However, it is preferable to dry the mold in an oven. For iron castings, the contractions to be taken into account vary slightly according to the nature of the work, but for general purposes it may be considered to be 1/10-inch per foot. However, in steel casting, the general allowance for contraction is between 3/32 and 3/16-inch per foot, and this creates one of the greatest difficulties with which steel molders have to cope. The outside of the rudder mold offers practically no resistance, but all the cores are under compression, and unless great care is taken in their construction to allow them to be crushed, the casting will break or twist out of shape.

Making the Core Mixture

A mixture suitable for cores for the rudder mold is made by reducing the strength of the composite, previously described by the addition of silica sand. Figs. 8 and 9 show the formation of two of the grids for the cores, the former being for the rudder post core and the latter for the largest core between the ribs. The prods which can be made of pieces of wrought iron cast into the plate, should clear the outside of the core by an amount varying with the contraction of the metal around it. Therefore, the clearance for the rib cores should be more than for the rudder post core, and since wrought iron prods yield more readily to pressure, they are often used in preference to cast iron prods. In constructing the cores, a bed of the weakened composition is formed, about 1 inch thick and the grid is bedded into it, the sides being then made with the same composite, about 3 or 4 inches thick; the inside is filled with ashes and a thin covering of composition is placed on top. The same method is applied to the rudder post core, but the coating of composition can be much thinner, 2 to 2½ inches will suffice. When the cores have been stripped and finished, a number of slots are cut to form brackets on the casting. These brackets are cast-on to counteract the tendency of the casting to crack while cooling, owing to sudden shrinkage. They should be used wherever the thickness of metal varies abruptly, their size depending upon this variation, but usually about ¼-inch in thickness. These ribs are knocked off when the casting is cleaned.

It is equally as desirable to provide for fins around the cores as around the mold. The impressions left by prints should be tapered off at the junction with the mold about 2 inches back, and the tops of the cores should be chamfered off in a like manner. Besides being useful for the purpose previously mentioned, they prevent the likelihood of crushing the corners when closing. In Figs. 10, 11 and 12 the setting of the cores is illustrated, Fig. 10 showing all the cores in position and the bottom

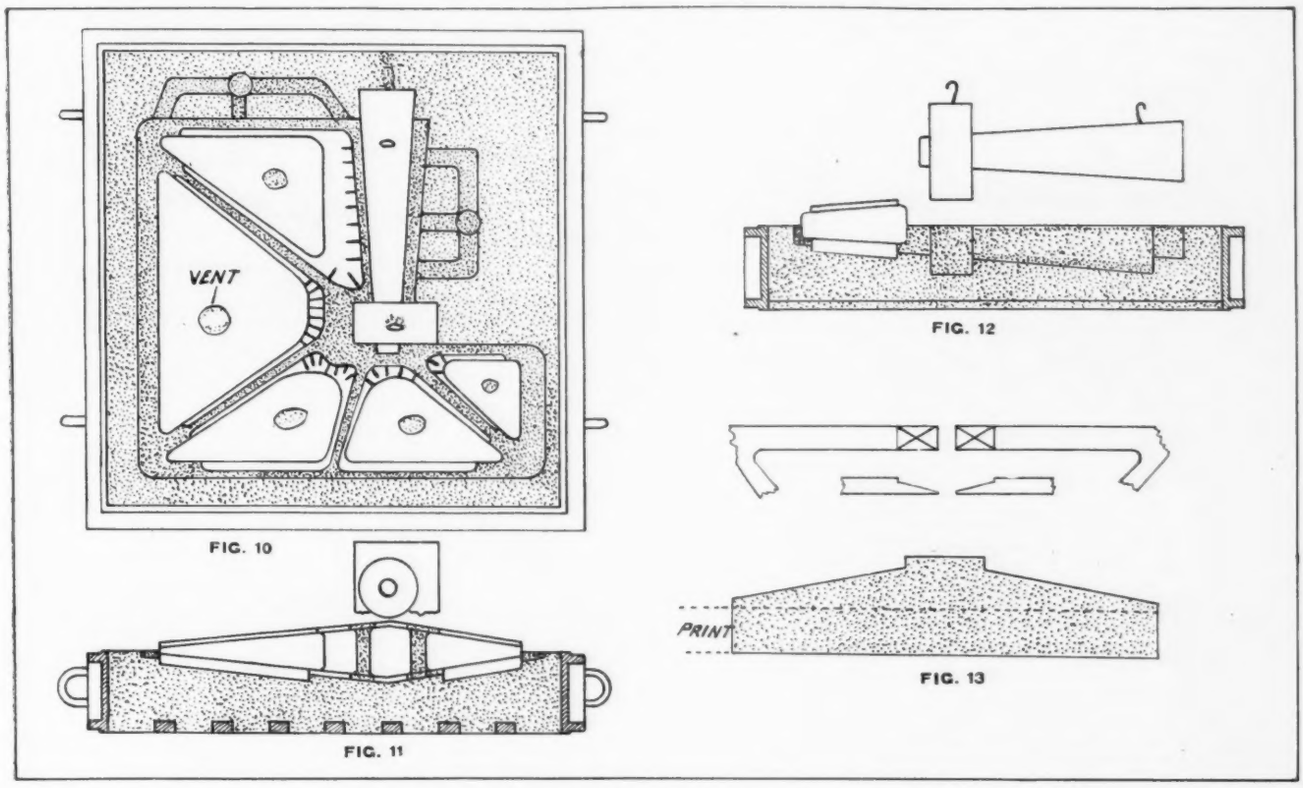

FIG. 10—THIS IS A PLAN VIEW OF THE MOLD WITH THE CORE SET, AND A SECTION OF THE MOLD IS ILLUSTRATED IN FIG. 11. THE METHOD OF SETTING THE RUDDER POST CORE IS ILLUSTRATED IN FIG. 12, WHILE FIG. 13 SHOWS AN ALTERNATIVE METHOD FOR REDUCING THE STRAIN ON THE RUDDER CASTING

of the mold ready to receive the cope, the contraction brackets being shown by thick, black lines.

When the cope has been lowered, after runners and risers have been found to coincide with the positions required, and the bearing on the cores and joints have been assured, pouring and riser basins previously prepared, are set in position. The two runner basins can be connected and used in conjunction, but it is often preferable to run into each separately. Fig. 14 shows a plan and elevation of the mold ready for casting. The basins are made fairly large to provide a good head of metal suitable for feeding the casting while shrinking. The illustrations show the flask secured by bolts. Much more care must be exercised in securing the flasks when the work is cast vertically; the head of metal then is greater and hence the pressure exerted will be increased. Steel sets quickly, and its fluidity is reduced by reason of its carbon content; hence, the milder the steel the less the fluidity. Under such circumstances it is of the utmost importance to cast in a vertical position whenever possible or at least on an incline, thus assisting the metal in its progress through the mold.

Compared with iron, owing to its more lazy movements, a much longer time is required to fill a mold with steel. When the job has been cast, the riser head should be given a supply of hot metal from the ladle. When such a job is cast on an incline, as shown in Fig. 15, it can be run in a similar manner as that shown for the horizontal position, but the basins for the heads should be carried up level and a riser brought off the top of the metal surrounding the rudder post. The method described for preparing the mold for this rudder is suitable when the pattern is blocked-up and the cores are made separately, but it is common practice, in steel molding, to prepare the majority of the cores upon the floor in the mold.

Both methods have their disadvantages. When cores are made separately more men can be employed on any given job, hence it is liable to be turned out more quickly in the foundry, but the difficulty of making suitable allowance for shrinkage is usually greater. Successful results, however, are obtained from both methods. With the exception of the rudder post core, which would necessarily have to be made separately, all the cores can be made in the mold. The bottom half of the pattern would be laid on a prepared bed, as previously described, the drag flask set over it, and the whole rammed up; floor sand should be filled between the ribs and prints formed on top are rammed last. When the flask is rolled over, this temporary sand is cleaned out, and the other half of the pattern is laid in position. The cores are built in a manner similar to that adopted with the use of a core box. All pieces on the pattern liable to interfere with the successful drawing of the core should be loosened. When these cores have been built-up, with cinders in the center, the cope flask can be lowered. In this case the top half of the pattern will remain down when the cope is lifted and any portion liable to cause a bad lift should be made loose so that it can be carried off in the cope.

Parts of the pattern which can be moved before the cores are lifted are removed, and when all the cores have been successfully withdrawn the main portion of the pattern can be taken out. Patterns of this kind are sometimes of a very frail nature, and while they may be constructed in halves in the pattern shop for convenience, sometimes they are screwed together in the foundry and bedded in the floor, as shown in Fig. 16. In this way the joint of the mold can be altered to reduce the amount of lift in the cope. The construction of the mold is the same except that bedding in the foundy floor determines the position in which the job is to be cast; hence, if it is desired to cast on an incline, it must be bedded-in at the angle desired.

When the job has been successfully cast and the heads broken off while hot,

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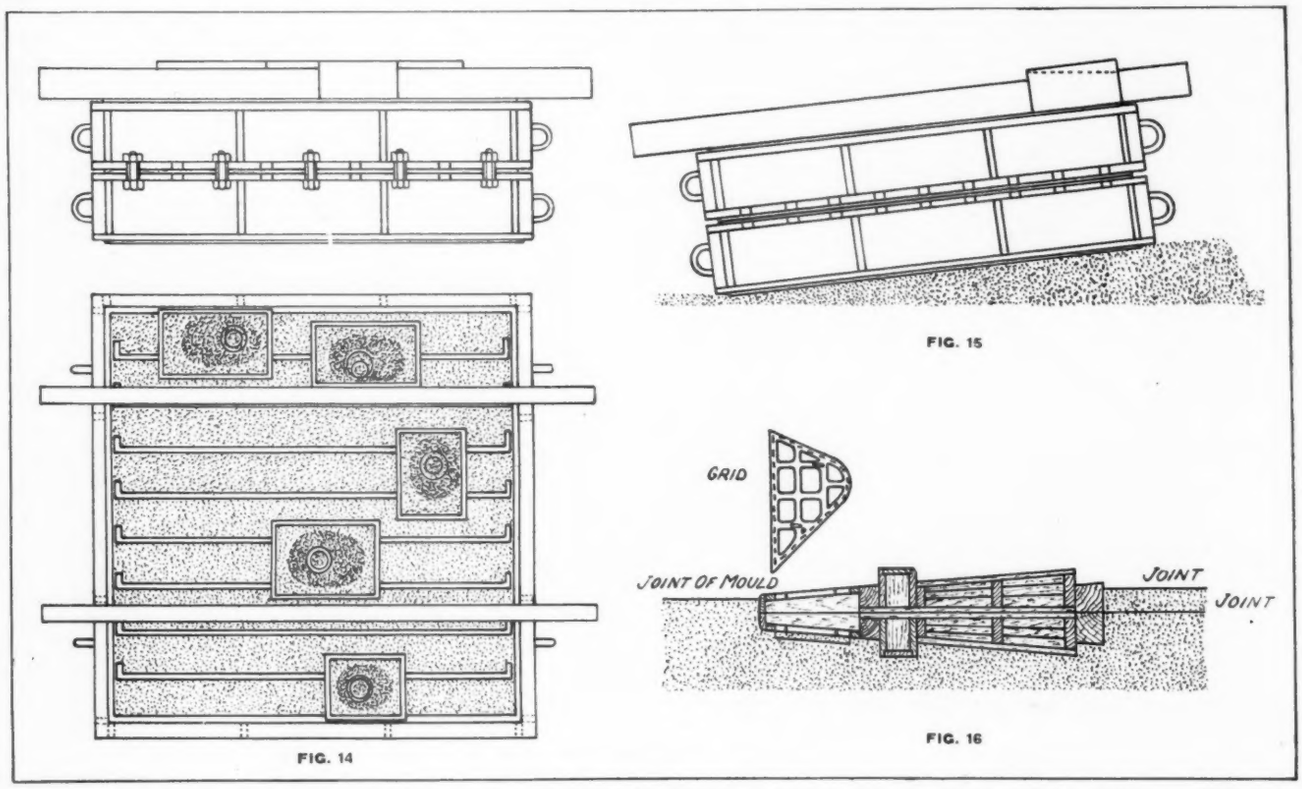


FIG. 14—THIS IS A PLAN VIEW OF THE MOLD READY FOR CASTING AND AN END ELEVATION OF THE FLASK ALSO IS SHOWN, ILLUSTRATING THE METHOD OF SECURING THE TWO HALVES OF THE FLASKS WITH BOLTS. A METHOD OF CASTING THE MOLD ON AN INCLINE IS SHOWN IN FIG. 15 AND FIG. 16 IS AN ALTERNATIVE BEDDING-IN METHOD OF MOLDING THE RUDDER, SHOWING THE JOINT PREPARATORY TO FORMING THE CORES

Bill Makes A Propeller

By Pat Dwyer

WHILE crossing over in the the ferry boat last Sunday, I met Bill, whom I had not seen for many weeks. I was glad to see him; in fact I was very glad to see him, for he is a loquacious lad and I am a champion long distance listener. I foresaw, that what I had expected to be a very quiet, tame little trip was going to be an interesting one. All I had to do was smoke my pipe and say nothing. We had served our time together—not in jail, you know, but in the foundry—though when you come to think of it, there is not so much difference. I have never been in jail—yet, but from what other men tell me who have been, I am of the opinion that jail life is much more comfortable than the life of an apprentice 20-odd years ago. After the usual greetings and telling each other how well we looked, the talk naturally turned to the foundry. Once started, all I had to do was listen. In addition to being a good listener, I have a fairly good memory. I will not give you his exact words, for Bill is a cheerfully profane person. Many years in the foundry have case-hardened me. and I was not unduly shocked. I asked him where he had been since I saw him last, and he grinned and said, "Just ask me some place I have not been. "Well," I said, "variety is the spice of life," and he said, "Yes, variety is the word," and continued: "When you consider the strenuous nature of the average molder's life, I am sure you will agree that he needs all the spice he can get. Of course, all molders are not alike. Some of them look on the day's work as a necessary evil, to be gone through in the easiest possible manner. Their minds are about 90 per cent blank all day, and their work is merely a series of mechanical movements. They derive no pleasure from it. If working by the hour, their ears are like a mule's all day, bent forward to catch the first toot of the knocking-off whistle; and if on piecework, they are constantly counting ahead, to see how many more flasks they have to put up before the wind goes on.

"Mind you, I am not denying that such men are useful. I suppose it is a merciful dispensation of Providence that there are large numbers of them. Otherwise the casting industry would be in a bad way. There are thousands of tons of castings produced in this country every year, repetition castings, with thousands from each pattern. If the men who made them had any imagination, the monotony would kill them. Still they have to be made, and as Mr. Dooley used to say, 'there y' are'. Well anyway, I am glad I have not got a job like that. I suppose that sounds kind of pharisaical, and I guess in some particulars all of us are more or less pharisees."

"Why," said I, surprised, "I did not know that you were so familiar with the Scriptures." "Well," said Bill, "I'll tell you, sometimes when I have nothing else to read, I browse through the pages of a very fine copy of the Bible I acquired one time. I did not buy it, neither was it given to me by a heathen missionary, or perhaps I should say, a missionary to the heathen, but I guess you get my meaning all right. Well, anyway, I have it and as I said, now and again I read some of it. I am frank enough to confess that I do not read it with the idea of fattening up my batting average, when the final score is made up. I am a man of simple tastes and simple manners. Oh, yes, I know you are going to say 'yes, and simple mind,

VARIETY IS THE SPICE OF LIFE

too, you poor fish,' but not wishing to start a fight we will let that pass, and I believe that a man's final score is made up from his intentions and not altogether from his external acts.

"However, as this is not a sermon, let's shake it out and start over again. Among the many parables, anecdotes, bits of history and biography to be found in that book is the little sketch of the pharisee and publican; not republican, dear friend, but just plain publican. I suppose since you are a democrat you will say its all the same. Go ahead with what you want to say and never mind dragging politics into it. I often think when reading that sketch and applying it to the foundry, that all of us have a dash of the pharisee in us.

"Just listen and I bet the analogy will strike you. These two lads took the same notion one day and went into the temple to pray. The pharisee went right up to the front, where the spotlight was shining, and spoke right out loud, so the reporters would be sure to get him correctly, 'Oh, Lord! take a good look at me, I am A-1 at Bradstreets; I don't lie, or cheat, or steal, nor charge more than 30 per cent on my loans; I pray out loud whenever there is a goodly audience; I give a tithe of all I possess to the poor, but it is so hard to find them, they live in such queer out-of-the-way places; and I expecially thank Thee that I am not like that disreputable character down by the door. Amen!' Then he went out. And though there is no mention made of the fact, climbed into what passed for a limousine in those days, and lighting a perfecto, languidly directed, 'Home James!'

THE PHARISEE CLIMBED IN HIS LIMOUSINE

"Now when I said I was thankful that I was not like some men chained down to the same thing day after day, I guess you thought I was springing some of the pharisee stuff. Well, perhaps I was. Still, while giving full recognition to the value of the men who work, day in and day out on the same job and thus make the vast casting industry of this country possible, I still maintain that pharisee or no pharisee, I now honestly thank the Lord that I have not got to do it. I want variety Change something to keep me interested in the day's work. You remember how I flew the minute I finished serving my time. I not only wanted new jobs, but I wanted to see how other shops handled old familiar ones. To that end I perambulated over this land of the free and the home of the brave for a good many years. Then I acquired a foreman's job—much in the same way I got the Bible—and believe me it is some job.

"I have a job with a firm that will undertake to make nearly anything. Most of the work is of the straight, legitimate, everyday type, the same as you see in any jobbing foundry; but there is enough queer, cranky complicated stuff comes in to keep me interested all the time. For instance, the boss comes in one day and says: 'Bill, there is a tug boat down in the harbor with a broken propeller. We have no pattern that will do. Go down and have a look at her and see what we can do.' "I went down and had a look. 'Well,' says the captain, 'can you make us a new one, and how long will it take?'

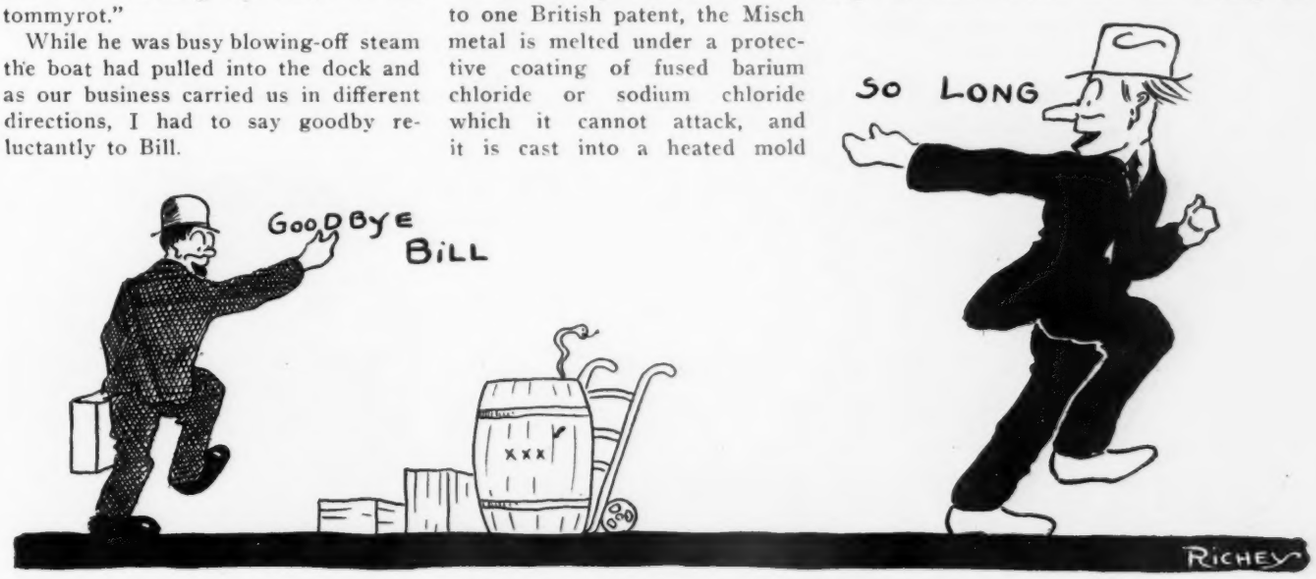
"'Sure,'" says I, 'we will have a new one on in about four days.' 'Go to it,' says he.

"The wrecking gang backs her up and takes the old wheel off and carts it up to the shop. It was originally a four-blade wheel; but there was nothing left but the hub and one blade. I made a templet out of laths and cast four arbors that night. Next day I placed the old casting on the core oven car, and having blocked it in position, put one arbor under it and rammed core sand between the blade and the car, leaving the sand project past the casting about 3 inches all around to serve as a seat when locating the core when in its final position. This operation was repeated until all four cores were made. They were not really cores, but copes. But you know how it is, anything that is made on the core oven car is a core. While this was going on, a hole was dug in the foundry floor, about 18 inches deep and 8 feet in diameter, a cross and spindle set up, and a bed swept, not level, but at approximately the same angle as the sweep of the blades. A ring was scratched on this bed about 30 inches from the center, and on this four points were located equidistant from each other. The old casting was then placed in position for the first blade, the other face, of course, having been turned down. Sand was rammed underneath until within a couple of inches of the top, then one of the cores, dry and blackwashed, was lowered into place until it rested properly on the blade. The rest of the under part of the mold was rammed, getting the sand firm under the part of the core left projecting for a bearing. The cope was now staked and lifted off. The pattern was shifted around to the next point and the process repeated until all four blades were attended to. The pattern was lifted out for the last time, the mold finished and blackened and the copes replaced. The open places in the sides of the hub were made up, a center core and covering core placed in position — and, by the way, that is all the pattern-making there was on the job—making a frame with which to sweep a chamber core. A flat iron cope was placed over all, the cores wedged down from the bars and rammed full of sand. The runner and riser were made up and the mold was cast. The machinists took it next day and did their little bit and then the wreckers got it and fastened it into place.

"I have made propellers, big ones and little ones, made them with a separate cope for each blade, and made them by barring-up copes to take in the whole wheel, but I consider that one the easiest, cheapest and quickest wheel yet. Of course, I am not talking now of standard wheels made with standard rigging, I am simply talking about odd jobs when there is only one casting to make and the price of a pattern and rigging has to be considered. In this connection I wish to say that there is a lot of time wasted, both in the pattern shop and foundry, on jobs of this character. There is no sense in putting a piano finish on a pattern that is only to be used once. Neither is there any need of building it as strong as a freight car. The same

way in the foundry; there is no need of getting up elaborate rigging, wasting time venting plain surfaces, making-up fancy flow-offs and putting air-tight covers on all risers. The only risers needed are those to be used as feeding heads and there is no need of covering them. I have not covered, nor allowed to be covered, a riser for the past 20 years, and I guess I have seen enough different kinds of castings poured in that time to justify my belief that covering up risers is all tommyrot."

While he was busy blowing-off steam the boat had pulled into the dock and as our business carried us in different directions, I had to say goodby reluctantly to Bill.



OUR BUSINESS CARRIED US IN OPPOSITE DIRECTIONS

Casting Rare Earth Metals

By C. Vickers

Oxides of the rare earth metals formerly were a by-product of the gas mantle industry and an effort to utilize this waste led to the discovery of the pyrophoric alloys. When the oxides were reduced to the metallic state a metal was obtained consisting principally of cerium and carrying varying percentages of other elements, the oxides of which were mixed with the cerium. This material before it is reduced to metal is accumulated in the manufacture of gas mantles. The material from which these mantles are made, known as monazite sand, consists in small part, namely from 5 to 7 per cent, of the oxide of the element thorium that is used for the mantles. After the thoria has been extracted, the bulk of the sand is left. Formerly this was thrown away until it was discovered that it could be converted into chlorides which, by electrolysis yielded what is known as Misch metal because of its mixed composition. It also is known as Auer-metal and produces sparking alloys when it is mixed with iron in the proportion of 70 per cent Misch metal to 30 per cent iron.

This discovery was made accidentally by Auer von Welsbach when whittling a piece of Misch metal attached to an iron wire that he had used as a cathode in reducing the chlorides to metal. He found that the nearer he cut to the iron core the more the metal would spark. Considerable difficulty is experienced in alloying the Misch metal and the iron, as the former is exceedingly active chemically. Therefore, when melted, it has a tendency to revert to the condition of an earth if the operation is not carefully conducted. According to one British patent, the Misch metal is melted under a protective coating of fused barium chloride or sodium chloride which it cannot attack, and it is cast into a heated mold at a temperature slightly above its melting point. In making the iron-cerium alloy by this method, the cerium with its combined impurities, is melted adding it gradually to a molten bath of barium chloride and about 10 per cent of iron in small pieces also is introduced. When the crucible is half filled with the molten metal, loose coils of iron wire, 40 or 50 grams in weight, are added until the alloy contains 30 per cent of iron. The temperature is then raised to 1000 degrees Cent. and the metal is gently stirred; after removal from the furnace it is poured into iron molds clamped by angle bars and bolts. The crude metal usually is broken up and remelted under a flux to purify it. A small amount of copper or magnesium also is added to increase the temperature of the spark.

Making Castings Used in Ship Construction

(*Concluded From Page* 300)

the process of relieving the mold must follow as quickly as possible and the casting must be removed from the flask at the earliest moment.

A method for releasing strain on rudder frames sometimes is adopted by inserting a core in one of the sides, as shown in Fig. 13, the portion which is cut out being made a convenient shape for scarfing-in an extra piece after the work has been cast and annealed. This alteration is usually made at the foundry and is done merely to reduce risk of breakage from strain.

Annealing must be resorted to on all these castings, the effect being to dissipate the internal strains. The casting should be supported in a sealed furnace, the temperature of which is gradually raised until the casting becomes heated to such an extent that the parts formerly in compression or tension contract or stretch and thus cease to act upon each other. While it is necessary that the increase in temperature of the annealing furnace should be gradual, it is more essential that the reduction in temperature should be slow and gradual, so that whether the parts of the casting are slender or massive, they will cool at the same rate and thus insure the absence of all stress when finally cooled.

How Corrosion of Condenser Tubes is Effected

The corrosion of condenser tubes is known to be electrolytic in nature, but it was believed that zinc was the element attacked. Recent researches, however, have shown that the copper as well as the zinc goes into solution and is subsequently precipitated upon the tube in a spongy condition. Some experimenters, however, do not believe that the copper is attacked. They contend that the spongy deposits of copper represent brass from which the zinc has been removed and which has been loosened from the main mass of metal by the mechanical action of air bubbles and has been carried to other parts of the tubing to which it then attaches itself.

Metallography Applied to Nonferrous Metals---IV

The Aluminum Series of Alloys is Interesting and the Results of the Addition of Such Hardening Elements as Copper, Tin, Zinc, Iron, Nickel, etc., is Discussed

By Ernest J Davis

ALUMINUM, with a specific gravity of 2.58 is the lightest metal in common use and on this account, it has been suggested for a number of uses where lightness is essential. The properties of the pure metal, however, unfit it for purposes where it is likely to be subject-

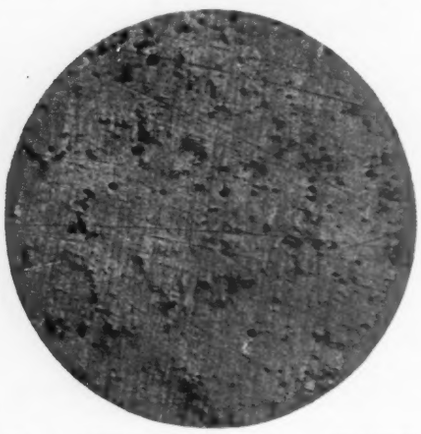


FIG. 1—MICROPHOTOGRAPH OF A DURALUMIN BAR; MAGNIFIED 100 DIAMETERS

ed to stress or to wear, as it is weak and soft in the pure state. However, it may be strengthened and hardened by the addition of foreign elements without suffering a serious increase in weight. A large number of light alloys of which aluminum is the principal constituent are now in general use, the number and application being considerably increased during the last four years, so that the aluminum alloy industry is now well established.

Pure aluminum, polished with due regard to its softness and etched with hydrofluoric acid, gives a homogeneous polyhedric structure when examined under the microscope, the size of the crystals depending upon the rate of cooling or on subsequent working and annealing. The chief hardening elements used in the aluminum industry are copper, zinc, manganese, magnesium, tin, iron and nickel. Manganese probably is one of the best hardeners, and may be added as a rich ferromanganese alloy for castings. Tin improves the strength and rigidity of the castings; it also gives sharpness of outline with a decrease of shrinkage of the alloy. Where toughness combined with hardness is required, aluminum-nickel alloys give good results. The alloys of aluminum and tungsten are especially suited for rolling and may afterwards be spun; but these alloys are generally more complex than the binary alloys and contain besides tungsten, such metals as copper, iron and manganese. Aluminum alloys hardened with chromium retain their hardness after annealing and in combination with copper and titanium, produce hard, tough and light alloys.

Aluminum-Copper Alloys

The microstructure of the heavy alloys of this series has already been referred to and passing now to the aluminum end of the diagram, Fig. 1 of Article III, published in the May 1 issue, we note aluminum is capable of holding up to 4 per cent of copper in solid solution. Such alloys either have a cored or homogeneous polygonal structure, according to the method of cooling from fusion. With more than 4 per cent of copper the appearance of the eutectic makes the alloys hard and brittle and of little industrial value. As the amount of the eutectic increases, the alloys become more and more brittle and finally we have an alloy which can be ground to powder. An alloy of 8 per cent copper and 92 per cent aluminum has been used in France for some years for railway bearings; its microstructure consists of the hard and brittle eutectic embedded in a soft matrix of solid solution of copper in alu-

FIG. 3—MICROPHOTOGRAPH OF A 5 PER CENT ALUMINUM-ZINC ALLOY; MAGNIFIED 100 DIAMETERS

minum, the essential conditions for a bearing metal. This alloy, however, is not used extensively in England. Aluminum-copper alloys have a large field of usefulness in the motor industry, where strong and light properties are necessary, but in recent years there is a tendency to use alloys of the ternary class rather than those of two metals only. Duralumin is an example of the excellent properties of some of these alloys, and the microstructure of a sample of Duralumin bar is given in Fig. 1, at a magnification of 100 diameters. The next most important series of aluminum alloys is that of those with zinc. In this series we have a well-defined eutectic and at one end of the series a long range of solid solutions, while the series also shows one definite chemical compound possessing somewhat remarkable features. The equilibrium diagram for the alloys of aluminum

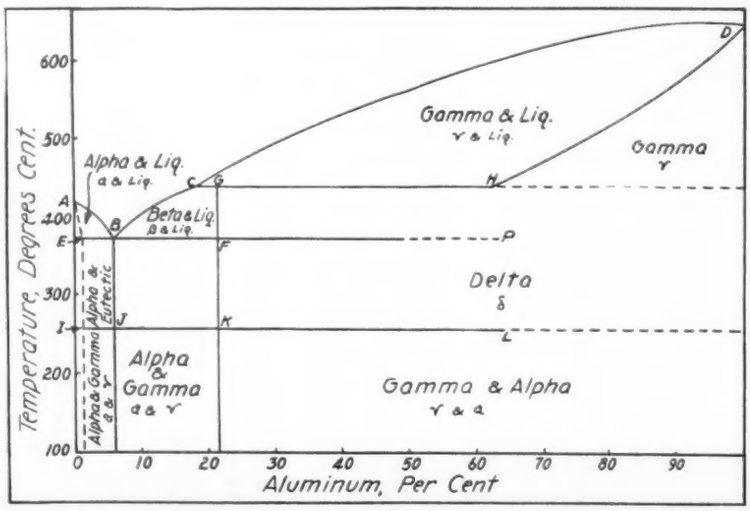


FIG. 2—EQUILIBRIUM DIAGRAM OF THE ALUMINUM-ZINC SERIES OF ALLOYS

and zinc, Fig. 2, has been worked out complete with the exception of the dotted lines, by Dr. Rosenhain and Archbutt. The liquidus, *A, B, C, D,* consists of three branches corresponding to two solid solutions, alpha and gamma. Starting from the point *A,* the liquidus runs down to the eutectic *B* at the composition of about 5 per cent of aluminum.

Fig. 3 is a microphotograph of a 5 per cent aluminum-zinc alloy magnified 100 times. From this point the liquidus

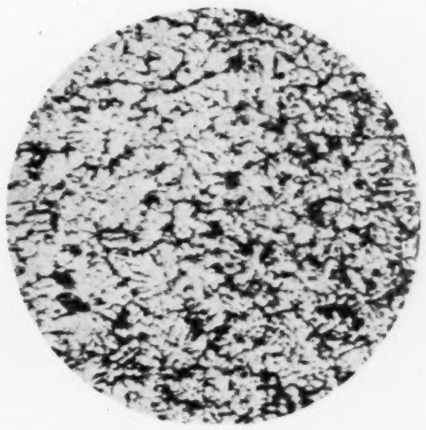


FIG. 4—AN ALUMINUM-ZINC ALLOY CONTAINING 20 PER CENT ZINC; MAGNIFIED 100 DIAMETERS

curve runs up smoothly to a point *C,* where a small break is formed, and then again to the point *D,* Fig. 2, corresponding to the melting temperature of pure aluminum. The solidus curve is given by the line *A, E, B, F, G, H, D.* There is rather a curious feature about the solidus curve of this series of alloys, namely, the step up at the point *F,* corresponding to the concentration of about 78 per cent of zinc, which represents the formation of the compound $Al_2 Zn_3$. To understand this part of the diagram it is necessary to study the manner in which this compound is formed in these alloys. Along the branch of the liquidus between the points *C* and *D,* the alloys begin to solidify when cooling by depositing crystals of a solid solution of zinc in aluminum, this solution being called gamma by metallographists and noted as such in Fig. 2. As the alloys cool further they continue to deposit an increasing quantity of this gamma phase until they reach a temperature of 430 degrees Cent., which is indicated in the diagram by the horizontal line *CGH.* Alloys lying at the right of the point *H,* that is those containing more than 60 per cent of aluminum, become completely solid before they reach this temperature, and in that case it is possible that no further change takes place in such alloys, although the dotted continuation of the line *GH,* seems to indicate some further change. At the left of the point *H,* however, the alloys are still partially liquid when the temperature of 443 degrees Cent. is reached, and then a chemical reaction set in resulting in the absorption of the residual liquid and the formation of the compound $Al_2 Zn_3$.

The crystals of gamma solid solution, already formed as a result of the foregoing reaction, become coated with a layer of the newly formed compound, and as soon as this layer is completed, the reaction in the ordinary way comes to an end, even though all the residual liquid is not used up. The remaining liquid in this case is in a meta-stable state and remains as such until the temperature of the line *B, F, P* is reached, where the residual liquid solidifies as the eutectic.

This is indicated in the diagram by the dotted part of the line, *F, P,* which was regarded as the eutectic line in the earlier diagrams, but by keeping these alloys at a temperature of about 443 degrees Cent. for a considerable time, the formation of the compound $Al_2 Zn_3$ is completed by the slow diffusion, and further cooling results in no further change at the line *FP.* This statement holds good for all alloys which contain less zinc than the quantity required to convert the whole of the alloy into the compound $Al_2 Zn_3$, that is, for alloys lying to the right of the line *F, P.* To the left of *F, G,* we have a different condition. Regardless of the time of annealing at 443 degrees Cent., the alloys will not be completely solid at this temperature. The reason of this is that even after the whole of the gamma crystals have been converted into the compound, a residue of liquid remains which finally solidifies as an eutectic of zinc and the compound $Al_2 Zn_3$ at the temperature of the line *BF,* this line extending almost to the zinc end of the series. The line *GH* nearly represents the temperature which limits the stable existence of the compound

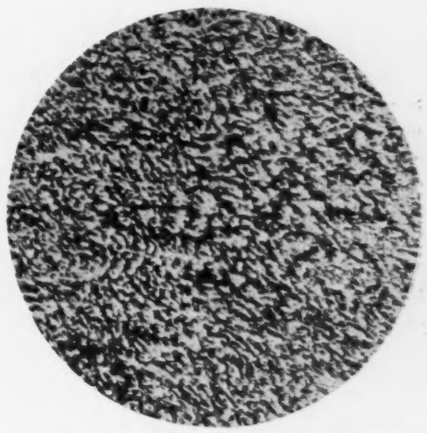


FIG. 6—A 20 PER CENT MAGNESIUM ALLOY; MAGNIFIED 100 DIAMETERS

$Al_2 Zn_3$, so that when the alloys are cooled through that temperature the compound is formed, and when they are heated above that temperature, the compound is decomposed. Therefore, alloys to the left of the point *C,* on cooling, begin to solidify by depositing crystals not of the gamma solid solution, but of the compound $Al_2 Zn_3$. This difference accounts for the small break in the liquidus curve at *C.* The horizontal line, *I, J, K, L,* at a temperature of about 256 degrees Cent marks the lower limit of the stability of the compound $Al_2 Zn_3$. On cooling the alloys within this range below 256 degrees Cent. marks the low- $Al_2 Zn_3$, breaks up into a duplex structure, which is sometimes very finely laminated and consists of crystals of saturated solid solution (gamma). Fig. 4 is a micrograph of a 20 per cent zinc-aluminum alloy at a magnification of 100 diameters. As will be noted from a study of the diagram, Fig. 2, the microstructure of the solid alloys will be as follows: Alloys up to 5 per cent of aluminum consists of alpha + gamma; from 5 to about 22 per cent of aluminum, we have

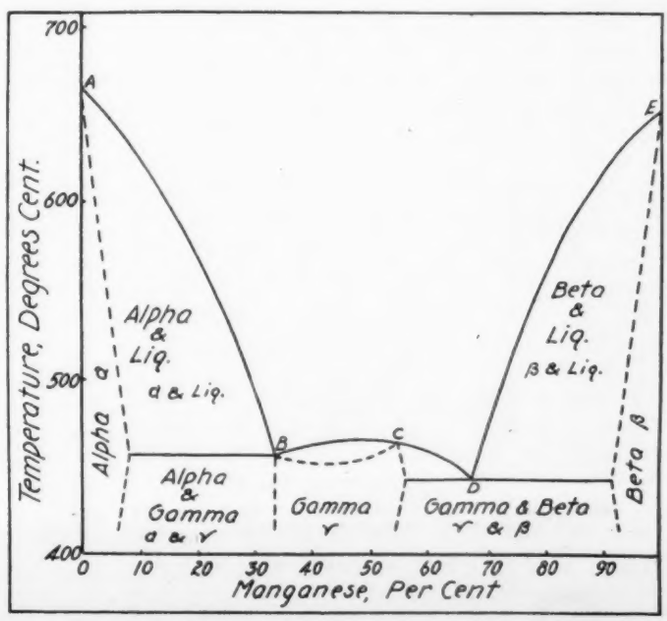


FIG. 5—EQUILIBRIUM DIAGRAM OF THE ALUMINUM-MAGNESIUM SERIES

alpha + gamma + eutectic and from 22 to 100 per cent of aluminum, the structure of the alloy depends to a large extent upon the heat treatment. Above 256 degrees Cent., delta solid solution is the stable phase, and in alloys with more than 60 per cent of aluminum above a temperature of about 443 degrees Cent., gamma is the stable phase, the method of casting determining the final structure of the solid alloy. The beta phase is only stable above 256 degrees Cent. and forms a rather characteristic structure, having six rays with angles of 60 degrees, the usual angles for such crystals being either 90 or 45 degrees.

The alloys of aluminum and zinc have been used for a number of purposes; up to 15 per cent of zinc they are comparatively soft and ductile enough to be rolled or drawn; but beyond this percentage of zinc the alloys become harder and are more suitable for castings. For many years aluminum-zinc alloys have been largely used for the construction of scientific instruments. The alloys are similar to bronzes in hardness and ease of working, but with over 25 per cent of zinc they become extremely hard and difficult to work; such alloys, however, are used extensively for castings in the motor car industry, although in recent years the practice is to use more of the ternary class of alloy. An analysis of a gear-case which gave a high tensile strength had a composition of 88 per cent aluminum, 10 per cent zinc and 2 per cent copper. Aluminum-zinc alloys become slightly harder with age, but no case of disintegration has yet been noticed.

The next series of aluminum alloys of any importance are those containing magnesium. In this series we again have a chemical compound, but owing to the flatness of the liquidus curve, its chemical composition has not been determined. The formula of this compound may be Al Mg, Al_3Mg_4 or Al_2Mg_3, the summit of the middle branch of the liquidus curve agreeing most nearly with Al_3Mg_4, although this formula would seem to be the least likely of the three suggested. The equilibrium diagram for this series is given in Fig. 5 and was worked out essentially by Grube. The liquidus, *A, B, C, D, E*, consists of three branches corresponding to three solid phases. The limits of solubility of the solidus have not been determined accurately and the sloping solidus lines, therefore, are shown dotted in the diagram; however, the data gathered indicate that the alpha phase can hold as much as 8 per cent of magnesium in solid solution and that the beta phase can contain as much as 6 per cent of aluminum. As will be noted from a study of Fig. 5, this series of alloys contains two eutectics, one at *B*, corresponding to about 65 per cent of aluminum occurring at a temperature of about 452 degrees Cent., while the second eutectic occurs at 440 degrees Cent., with a composition of about 31.5 per cent of aluminum. The composition of the gamma solid solution varies from nearly 65 per cent to about 41.5 per cent of aluminum; the first eutectic, therefore, is almost pure gamma while the second eutectic consists of about 72 per cent of gamma mixed with 28 per cent of beta by weight.

Assuming the diagram to be substantially correct, a slowly cooled alloy containing less than 8 per cent of magnesium solidifies to a homogeneous solid solution and gives rise to the typical solid solution structure. Alloys between 6 and 35 per cent of magnesium, on microscopic examination show primary crystals of the aluminum-rich constituent alpha surrounded by the eutectic of pure gamma. Between 58.5 and 68.5 per cent of magnesium, the alloys consist of primary gamma crystals in a matrix of the beta-gamma eutectic. From 68.5 to 94 per cent of magnesium the alloys solidify to a homogeneous solid solution. Fig. 6 is a microphotograph of a 20 per cent magnesium alloy, magnified 100 diameters. The alloys of magnesium were first prepared by Wohler in 1866, and also by Parkinson in 1867, who claimed that these alloys were of no use in the arts. Evidently these experimenters had used alloys with high magnesium contents and it was left to Dr. Mach to discover that small quantities of magnesium, in a marked degree, improved the mechanical properties of aluminum, thus affording another example of the utility of alloys which occur at the ends of a series of alloys; while approaching equal quantities of each element the alloys become weak and brittle and consequently are not of any use for general engineering purposes.

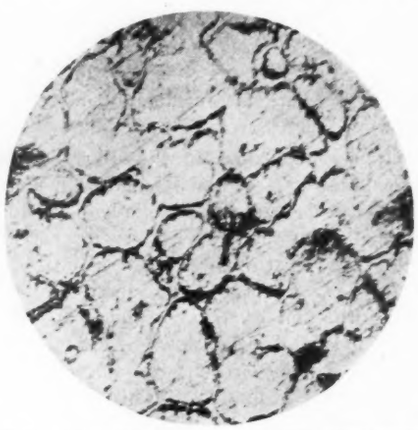


FIG. 7—AN ALUMINUM-TIN ALLOY CONTAINING 30 PER CENT TIN; MAGNIFIED 100 DIAMETERS

One of the best known commercial alloys of magnesium is that known as magnalium. The magnesium content at present employed is usually between 1 and 2 per cent, and contains, as a rule, similar quantities of copper, nickel and tin, according to whether the alloy is to be cast or drawn. The principal use of this class of alloy is in the manufacture of scientific instruments; it also has been recommended for the manufacture of cylinders and pistons of gasoline engines. These alloys are claimed to have sufficient strength for this service and have the additional advantages of light weight, low coefficient of friction and high thermal conductivity which prevents overheating. Another advantage in the use of these alloys is that dilute acids have very little effect upon them and can thus be employed with perfect safety for the manufacture and use of cooking utensils. The microstructure of this class of alloys, as will be seen from the diagram, Fig. 5, is that of the alpha solid solution, the ternary element, if present, being completely soluble in the solid solution.

The liquidus of the aluminum-tin series of alloys is similar to that of the copper-bismuth series, in that the eutectic contains very little of the metal of the higher freezing point, but in the aluminum-tin alloys we have a certain range of solid solubility. The eutectic points occur at about 48 per cent of aluminum at a temperature of 229 degrees Cent., and its presence can be detected both thermally and microscopically in alloys containing 5 per cent of tin, but slow cooling or annealing allow of more tin being dissolved in the solid solution of aluminum, the limiting concentration of this solution being about 20 per cent of tin. The microstructures of these alloys are quite simple. Alloys containing up to about 20 per cent of tin consist of a homogeneous solid solution of tin in aluminum, and show the well-known cores. Above 20 per cent of tin we get alloys containing increasing amounts of eutectic until we come to the eutectic composition, when this alloy then contains all eutectic and shows under the microscope the typical banded structure. Fig. 7 is a microphotograph of a 30 per cent tin alloy, magnified 100 diameters.

The alloys of aluminum and tin have been suggested for a number of uses and are employed largely for the interior parts of scientific instruments, especially optical instruments, a 9 to 10 per cent tin alloy being preferred. Up to 20 per cent of tin the alloys have been used for making light castings for various purposes. Castings of such alloys have a fine, white color, but are attacked by sea water and are readily

oxidized in exposure to the atmosphere.

Nickel has been added to aluminum as a hardener in the place of copper. As in the case of most binary systems, only those alloys at the extreme end of the series are of any practical use. Alloys of aluminum and nickel up to 10 per cent of nickel have been used for castings where maximum strength and toughness are required. Up to 2 per cent of nickel some valuable mechanical properties have been obtained. Above 5 per cent nickel the alloys become brittle and useless. The aluminum-nickel alloys are more or less noncorrosive and are not readily attacked by sea water. The microstructure of the alloys with less than 5 per cent nickel consists of crystallites of a brittle compound corresponding to the formula $Ni\ Al_6$, embedded in practically pure aluminum.

The aluminum-nickel alloys are used principally for castings, but the present day practice is to use more of the ternary class of alloy in which nickel is added in small quantities to insure toughness.

When added to aluminum, manganese forms a definite chemical compound, $Al_3\ Mn$, which tends to make the alloy hard and brittle. If present in large proportions, this compound appears to undergo a gradual change, which leads to spontaneous disintegration of the alloys containing it. An alloy consisting of 65 per cent of aluminum and 35 per cent of manganese is a hard, metallic mass when first cast, but falls to a fine crystalline powder in the course of a few hours. Small percentages of manganese render the alloy more ductile without reducing their ultimate strength, especially in alloys of the Duralumin type, while larger proportions increase the strength, but the ductility is rapidly reduced and the alloys become useless.

Cobalt has been recommended for improving the quality of aluminum. With 9 to 12 per cent of cobalt the castings are free from porosity and are harder, more easily worked and more resistant to corrosion than pure aluminum. The structure of these alloys is coarsely crystalline, which accounts for their low tensile strength, but this coarse structure may be refined somewhat by the addition of tungsten or molybdenum. Alloys containing 9 to 10 per cent of cobalt, 0.8 to 1.2 per cent of tungsten and 0.6 to 1 per cent of molybdenum have a tensile strength three times that of aluminum and have good forging properties. The molybdenum alloys are softer than those containing tungsten. The most suitable aluminum-cobalt alloys for castings are those rich in cobalt, the lower members being entirely suitable for rolling.

Of the other binary alloys of aluminum, those with titanium may be mentioned. With 0.5 to 2 per cent of titanium the alloys are considerably harder than pure aluminum, and when rolled have an elasticity comparable to spring brass. Aluminum-titanium alloys of the foregoing composition will bear a cutting edge about as well as soft steel and have been used for the manufacture of fruit knives by reason of the slight corrosion.

Alloys of aluminum and vanadium also have been prepared by the aluminothermic process. At 1 per cent of vanadium a new constituent appears, forming brilliant crystals, which fill the whole field at 34.5 per cent of vanadium, corresponding to the chemical compound of the formula, Al_2V. This compound is hard and may be isolated chemically.

Before leaving the alloys of aluminum, we might mention the alloys of aluminum and lead. These alloys show for every mixture a complete separation into two layers, the bottom layer being pure lead and the upper layer pure aluminum. Cooling curves, therefore, show for every mixture two discontinuities, the upper one corresponding to the freezing point of pure aluminum and the lower one to the freezing point of lead. There are no data for the curve of liquid solubility, but the two metals show little tendency to mix even at a temperature of 1000 degrees Cent. The microstructure of these alloys shows the separation into two layers very distinctly and on this account the alloys are of no commercial value.

Casting Aluminum Alloys

In the casting of the alloys of aluminum, the temperature of pouring has a great influence on the strength of the casting. Since the strength of a given alloy is largely dependent on the size of the crystal grain, it is of primary importance to obtain a material with the correct structure. The desired closeness of grain is obtained in practice by casting at a suitable temperature in conjunction with a knowledge of the equilibrium diagram for the particular series of alloys under consideration. This casting temperature is of considerable importance and should be determined for each series of alloys. From recent investigation of the subject it appears that it makes little difference if the best pouring temperature is exceeded during a melt, as long as the metal is allowed to regain the best pouring temperature before pouring.

The name of the Aspromet Co., Pittsburgh, has been changed to the H. H. Robertson Co. The change of name involves no change in the management or the policy of this company.

Study Methods For Producing Crucible Graphite

To determine the possibility of producing satisfactory crucible graphite from Alabama flake graphite, an investigation was conducted by the department of the interior, bureau of mines, and recently reported in a comprehensive bulletin which outlines the various processes used and the results of each. A primary object of the work was to ascertain the most satisfactory means by which the low grade graphite concentrates produced from Alabama ores could be made into satisfactory crucible stock. The success upon two factors; the amount of satisupon two factors; the amount of satisfactory material that can be recovered by the finishing process, and on the ease and cheapness of the operation itself. These two factors were used in comparing the results.

As a hypothesis, Ferguson's requirements for crucible graphite were selected as the quality to be produced. The requirements are as follows: Graphite for the making of crucibles must be of great purity. Its contents of graphite carbon should exceed 85 per cent and preferably should be as high as 90 per cent, and it must be practically free from mica, pyrite, and iron oxide. A small amount of quartz is not injurious. Graphite for making crucibles also should be coarse enough for the interlocking fragments to be bound by the clay with which it is mixed. It should contain a large percentage of flake about 1 millimeter in diameter and should all remain on a 100-mesh screen.

Opens New Plant

The Sanitary Company of America, Linfield, Pa., has put in operation its branch plant at East Greenville, Pa. This plant which was acquired recently will manufacture plumbers cast iron specialties. The officers of the company are E. M. Rhoads, president and treasurer; Grant P. Bechtel, assistant treasurer; B. W. Frederick, secretary, and L. A. Shiffert, assistant secretary.

Organizes Foreign Department

The Sullivan Machinery Co., Chicago, recently has organized a foreign trade department under F. W. Copeland, formerly manager of the St. Louis office of the company. The purpose of this department, which has its headquarters in Chicago, is to coordinate and assist the foreign branches and agencies in developing trade opportunities.

The Gellert Engineering Co., Widener building, Philadelphia, is installing electrical precipitators for cleaning flue gases from the furnaces of the American Manganese Mfg. Co., Dunbar, Pa.

HOW AND WHY IN BRASS FOUNDING

By Charles Vickers

Making Solder for Repairing Bronze

Will you kindly inform us how to mix up a solder that can be used to solder an alloy of copper, 80 per cent; tin, 10 per cent and lead, 10 per cent, and which will match the color of this alloy. It is preferable the solder be low melting in order to be easily handled with the iron. Copper solders have been tried but difficulty was experienced owing to their high melting points.

As all low melting point metals are white, or bluish in color it is obviously impossible to produce colored solders therefrom. As a result it is not possible to present a formula for a solder that can be used with a soldering iron, that may be applied easily, and that will possess a color similar to that of the bronze casting on which it is used.

High melting point spelter solders will have to be used and the castings will have to be brazed. An expert with the acetylene torch might be able to do a better job than can be obtained by brazing, and the color of the metal used would more nearly approach that of the bronze. The only alternative is to color the solder, by first copper plating it, then brass plating it and oxidizing to the color of the casting, unless the latter is polished. If it is merely a question of filling holes, obtain a quantity of clean grindings from the castings to be plugged and immerse them in a soldering solution, such as zinc chloride. Have a quantity of plumbers wiping solder melted until pasty, or a little beyond and mix the brass grindings with the solder until the latter resembles bronze. Use this hot for plugging the holes by squeezing it in while pasty.

Preventing Pin Holes in Aluminum

When we cast aluminum we frequently find small pin holes on the upper surface of the castings, and we desire to learn if this is due to overheating of the metal.

Pin holes in aluminum castings are caused by pouring at too high a temperature into the molds. The more rapidly the metal sets after it gets into the mold, the better it is for the castings, because aluminum is one of the most chemically energetic of all metals the brass founder uses. If it is permitted to remain in contact with damp sand while molten, it is acted upon by the moisture; in other words, the aluminum is corroded, and if hot enough to show red it will decompose the water and combine with the oxygen and absorb the hydrogen. It is the latter that causes pinholes. Overheating in the furnace is less harmful than pouring too hot, into sand molds. Metal overheated in the furnace may show black specks in the casting, because the temperature has been high enough to permit it to oxidize. The product of this oxidization is in part a lower oxide of aluminum than alumina, and this lower oxide is black, and is almost always formed because aluminum attacks its own oxide and reduces it, therefore, if black specks show, watch the melting part; and if pin holes are present reduce the pouring temperature.

Separating Metal from Slag

We have on hand a large amount of slag from white metals consisting of from 45 to 50 per cent metal, of the composition lead, 80 per cent; tin, 16 per cent; antimony, 3 per cent and copper, 1 per cent. We would like to know what flux to use to make it flow freely, and separate from the slag.

The best way of separating the metal from the slag is to liquate it in a reverberatory furnace having an inclined hearth. No attempt should be made to get a fusible slag and therefore no flux is necessary. The charge is simply heated until the metallic portion melts and runs away and is collected in a kettle kept under the tap hole and separately heated. The residue left in the furnace after all the metal has been sweated off, is raked out and afterwards treated in a blast furnace with about 5 per cent of small coal for recovery of the lead that is contained. The greater part of the metal is separated by the first liquation and runs out of the open spout of the furnace into the ladle placed to receive it. This metal can be cast into pigs and an analysis made to determine its composition after which it may be remelted in a babbitt kettle and other metals added to bring it to some definite composition. If the alloy when remelted is thick and will not run freely, it should be deoxidized by submerging sticks of green wood in the bath which agitate the metal.

Melting Phosphor Bronze

We are making phosphor-bronze bushings that weigh 22 pounds each, and are experiencing difficulty in getting them sound as the castings when taken from the sand appear clean, but later when they are turned they are filled with holes. We purchase the bronze in ingot form, and as the molds are poured it acts normally as it comes up into the risers very quietly. Any suggestions you may offer will be appreciated.

We are inclined to blame the methods of melting the ingot. Possibly the metal is not properly protected during the time it is exposed in the furnace. Be careful to use not less than an inch of charcoal and if phosphor copper is available place about ¼ pound in the bottom of the crucible with each melt of 100 pounds of ingot. It is not advisable to use any fluxes with phosphor bronze as they are likely to contain lime or soda. Simply use plenty of charcoal and have the metal well protected at all times while it is melting. Sulphur, which comes from the fuel, must be guarded against in making phosphor bronze. Oxygen in the absence of sulphur will work no harm; it merely removes the phosphorus gradually by oxidization, and as there is usually an excess of phosphorus it would require a long period of oxidation in a brass melting furnace to remove it entirely. If in spite of all the melting precautions that may be taken, the castings continue to be porous, it would be well to take up the matter with the producer of the ingot metal.

Molding and Melting Practice for Making Globe Valves

While making 6-inch globe valves of 88-10-2 mixture we have had considerable trouble due to leakage under water pressure which we are at a loss to account for. The leakage is usually the worst at points just back of the flanges. The thickness of the flanges is 1¼ inches, and of the body ⅝ inch. The castings are poured from the bottom with a horn sprue, and a riser is taken off the body, the molds being thoroughly dried.

All new metal is used with the remelt scrap and it is melted in an open-

Miscellaneous Mixtures

Acid Resisting Alloy

Irmann's alloy for resisting hot, concentrated sulphuric acid, may be made as follows:

	Per cent
Copper	41
Nickel	50
70 Per cent ferrotungsten	6
10 Per cent aluminum bronze	2
30 Per cent manganese copper	1

Melt the copper and the nickel together under a flux of fluorspar with a little lime and when thoroughly liquid, add the ferrotungsten in a pulverized form; stir thoroughly, add the aluminum bronze and the manganese copper. A high temperature is required to make the alloy.

Nergandin Alloy

This alloy is used for condenser tubing as it is highly resistant to corrosion. The alloy follows:

	Per cent
Copper	70
Zinc	28
Lead	2

Melt the copper under plenty of charcoal, add the zinc gradually and charge the lead last.

A Good, General Acid Bronze

	Per cent
Copper	85.25
Tin	9.25
Lead	4.50
15 Per cent phosphor copper	1.00

Melt the copper under charcoal, add the phosphor copper, allow the mixture to stand for 5 minutes, then add the tin and the lead.

FORMULAS FOR THE BRASS FOUNDRYMAN

Miscellaneous Mixtures

Hydraulic Metal

Guillet's hydraulic metal consists of the following metals:

	Per cent
Copper	82
Tin	8
Zinc	5
Lead	3
Manganese	2

The manganese is added in the form of metallic manganese or as 30 per cent manganese copper. With 2 per cent manganese, however, the alloy is liable to be difficult to run. In practice, the manganese should be reduced to the addition of 0.5 per cent of 30 per cent manganese copper.

High Pressure Bronze

	Per cent
Copper	82.00
Tin	7.50
Zinc	5.00
Lead	5.50

Another High Pressure Bronze

	Per cent
Copper	90
Tin	6
5 Per cent phosphor tin	4

Bronze to Withstand High Pressure Carbon Dioxide

	Per cent
Copper	80.00
Tin	7.50
Zinc	12.50

Hydraulic Bronze

	Per cent
Copper	85
Tin	11
Yellow brass clippings	4

THE FOUNDRY DATA SHEET, MAY 15, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may cut into two sections, 6 x 7 inches, and may be readily bound in note book form.

flame furnace, the copper and gates first then the tin and the zinc is added. About ½ hour is required to melt a 500-pound heat and when melted about 1 ounce of phosphor copper to the hundred pounds of metal is added in the ladle, and the castings are poured at about 2000 degrees Fahr. The test bars give the required tensile strength, and the castings appear perfect until tested.

There are several reasons for the difficulty experienced from leakage of these castings, but probably the most important is the fact that the molds are being poured at too low a temperature for this particular alloy. The metal in the furnace should be heated to about 2400 degrees Fahr. This will give plenty of time to tap or pour out the metal into ladles, allowing for the chilling in doing this, and then get it to the molds at the proper casting temperature, which is a few degrees under 2200 degrees Fahr. The alloy has, therefore, been poured 200 degrees Fahr. too cold. Another important consideration is the feeding of the castings to avoid seeping away of the eutectic from between the crystals, at those points that solidify last. Do not place the feeders on the thin body of the casting, but connect them to the heavy flanges, so the latter can draw liquid from the risers. In short, have the cause of the leakage in the risers instead of the castings, because it is cheaper even though twice the present amount of metal must be used for risers. If risers cannot be applied, chills of graphitic carbon must be placed at the juncture of the flanges and the body of the casting, and the chills must be heated before the molds are poured.

Casting Aluminum Patterns

We would be thankful if you could advise us the proper mixture for casting aluminum patterns. We have been using scrap aluminum but the castings are brittle and easily cracked by rapping after a few days use. We thought that perhaps by the addition of some other metal this could be remedied.

There is no better alloy for casting aluminum patterns than No. 12 aluminum, which can be purchased in ingot form from any dealer. It is doubtful if the brittle scrap aluminum can be improved, and if this is attempted by the addition of pure, soft ingot aluminum the results might be unsatisfactory. It would be advisable to dispose of this material and obtain the regular No. 12 aluminum ingot, which should consist of approximately 8 per cent copper and 92 per cent aluminum. When made from secondary metals this alloy may contain up to 2 per cent of zinc, but this addition will not injure its usefulness for the purpose outlined.

Specifications for Car Journal Bearings

Will you send us data regarding the analyses of railroad car journal bearings?

The following specifications for car journal bearings with the names of the railroads advancing them were given by G. H. Clamer, Ajax Metal Co., Philadelphia, in a paper presented before the American Institute of Metals and published in Vol. IX, of the *Transactions* of the institute:

	Copper, per cent	Lead, per cent	Tin, per cent	Zinc, per cent
Atlantic Coast Line..	73	15	9	Max. 3
Balti. & Ohio.....	72–80	10–16	over 7	.....
Barney & Smith Car Co.	65–70	15–20	4– 5	10-15
Boston & Maine....	77–80	9–11	7– 9	Max. 5
Bess. & Lake Erie...	78–80	10–13	9–11	.....
Canadian Pacific.....	65	15	7	Max. 3
Chicago & Alton....	75–80	10–14	7–10	.....
Chicago, Burlington & Quincy	77–81	9–11	9–11	Max. 0.5
Central Railroad of New Jersey	77	15	8	.....
Chicago Milwaukee & St. Paul	80	10	10	.....
Great Northern	72–80	10–16	9	.....
Grand Trunk	72	15–20	7	.....
Lehigh Valley	68	25	4– 5	.....
Missouri Pacific	75–80	10–18	7–11	.....
Northern Pacific	72–80	10–16	9	.....
Phila. & Reading....	77	15	8	.....

Correcting Melting Practice

We are sending for inspection a sample casting made from an alloy containing copper 73 per cent; aluminum, 15 per cent, and iron, 12 per cent. You will note that the surface of the casting is pitted with fine holes gathered in clusters. The rough castings on the surface show a hole no larger than a pin, which on machining grow larger. They are always on the cope side; often extending half way through the casting. We melt in gas-fired furnaces using No. 40 pots, and the copper and the iron are charged together, melted and skimmed and then the aluminum is added. The iron is in the form of light tin plate clippings. In casting we have tried every conceivable method, horn gates, skim gates, casting on end, and various sized runners and gates and risers. We are reasonably sure that our trouble is not caused by faulty casting methods but either by wrong melting practice or by the analysis of the metal. We will certainly appreciate any help or any suggestions you may offer.

The melting practice is incorrect, but as there is no deoxidizer used with the alloy, the melting is only half to blame. Properly made this is an easily cast alloy, but as it has a high shrinkage it will require heavy sprues or risers to feed the metal solid. It is the hardest nonferrous alloy known and should show a brinell hardness of 350 using the 3000 kilogram weight.

In making the alloy, first melt the copper and get it hot, add the tin plate cold, and have it loosely coiled never pounded together. Use an iron stirrer, throw in the tin plate and immediately push it beneath the copper, add only a small amount at a time, no more than can be immediately submerged and when the copper begins to cool and will not take any more tin plate, add a small portion of the aluminum to throw the iron into solution. It is important to dissolve the iron as quickly as possible and to submerge it so that it will not oxidize. This is done by aid of the aluminum and thorough stirring. When the iron is charged with the copper it oxidizes before the copper melts. If it is necessary or more convenient to charge the copper and the iron together, and there is heat enough to melt them, use massive iron like round iron rods cut up. For a "deoxidizer" use 1 per cent of 10 per cent magnesium-copper.

Hose Nozzles and Steam Metal

A student specializing in metallurgical chemistry would like to obtain practical information on the subject of alloys. What is the cheapest and most easily machinable yellow brass for hose nozzles? I used an alloy of copper, 60 per cent; zinc, 35 per cent, and lead, 5 per cent, but the castings frequently cracked as they were being turned. I would also like the formula for a yellow brass that will stand expansion of at least 3/32 to 1/8-inch. Also what is a practical steam metal mixture? State the names of practical books on mixing metals and on brass core making.

Hose nozzles are made of cheap metal, usually scrap yellow brass, and the mixture you are using should be satisfactory although the alloy owing to the presence of so much lead is not strong. Possibly the cracking is due to careless lathe work. The following alloy is stronger: Copper, 66 per cent; zinc, 31 per cent; lead, 3 per cent. The following yellow brass has good elongation: Copper, 70 per cent; tin, 1 per cent; lead, 2 per cent; zinc, 27 per cent. Its tensile strength is around 30,000 pounds per square inch; elongation in 2 inches, 25 per cent; Brinell hardness number, 50 to 55; weight per cubic inch in pounds, 0.30. A practical steam, metal mixture is the following: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent, and lead, 5 per cent. No books have been published dealing with the subject of brass core making exclusively. You will find the subject of metal mixture covered in West's books on foundry practice. Also Boland's work on foundry operations. On the subject of alloying there is "Mixed Metals," by Hiorns, and "Practical Alloying," by Buchanan. For a student of alloy metallurgy, Rosenhain's "Physical Metallurgy" should also be quite valuable.

Pertinent Facts About Clay for Foundry Use

Color of Clay Is No Indication of Its Value—Various Factors Affect Melting Point and Bonding Power—How Clay Is Tested

By H F Stahle

THE color of clay is no indication either of its value for foundry use or of its refractoriness. Quite often in a clay mine or in a foundry you will hear it said that red clay is not fit for foundry purposes, but that blue clay is. And in text books, the rule is sometimes laid down that only a good blue clay should be used. The fact that a fire clay is blue simply indicates that it has not been exposed to the weather a long time. But clays generally are blue because they contain ferrous carbonate, or iron combined with carbon. If that clay is exposed to the weather, it will turn red, due to the fact that the ferrous carbonate becomes oxidized. Or it may turn yellow, due to the fact that it contains a hydrated iron oxide and lime.

Of interest to the foundryman is the relation of the composition of the clay to its melting point. Of course, for foundry uses clay has to be more or less refractory. It is supposed to be quite refractory; it is in fact, not always as refractory as it is thought to be. Three factors influence the relation of the composition to the melting point of the clay. The first of these is the physical condition of the impurities. For instance, sand will have a certain effect in lowering the melting point of a good clay. But how much will depend very largely on whether the sand is coarse or fine grained. If the sand is present as free silica in large grains only, the clay will melt down practically at its own melting point and will not be affected materially by the sand. If, on the other hand, the sand is ground up very fine, the same percentage of sand will have a very marked effect in lowering the melting point of the clay.

The same with lime. A chunk of lime as big as the little finger in a wad of clay will have very little effect in lowering the melting point of the clay. There will be a little reaction between the lime and the clay at the surface of contact, but inside the lime will simply burn to quicklime and ⅛ inch away from the lime, the clay will burn simply as clay, and there will be no general lowering of the melting point of the grain of clay in the presence of the grain of lime. But if the same amount of lime is ground up very fine and it is intimately mixed, it will lower the melting point of the clay as a whole. The size of the impurity, therefore, is an important factor in the effect of the composition on the melting point.

Another factor is the chemical combinations of the impurities; that is, the chemical combination in which the impurities are present. Take the case of lime. If it is present as calcium carbonate very finely divided, it will have a very decided effect in lowering the melting point of the clay. But if the lime is present as lime feldspar, already in combination with alumina and silica, the effect of the lime will not be as pronounced. This is largely due to the fact that when the mixture of limestone and clay are heated, the first thing that happens to the limestone is that the carbon-dioxide is driven off. Later the quicklime is left and the reaction of the alumina and the silica in the clay produces a very decided evolution of heat and that heat given off, due to the chemical reaction, has a very decided part in causing the clay to melt. In fact, it has been calculated that if radiation can be avoided, the heat given off in the reaction of the lime with the clay is such that the chemical heat will almost melt the clay itself without the application of any other heat. This must be taken into consideration.

Amount of Impurities

And the third point is the one that most people emphasize, the amount of the impurities. Of course the amount has a very decided influence in determining the effect of certain impurities on clay. In this respect, it must be remembered that these impurities do not act as oxides; that is, calcium oxide never causes the clay to melt. It will unite with some of the other clay and form calcium aluminum silicate or lime feldspar; then the lime feldspar reacts with the rest of the clay and it is this reaction which causes the clay to melt. In other words, these impurities form compounds which lower the melting point of the clay.

Only one oxide that I know of acts as a flux directly and that is the silica which is the chief ingredient of common sand. Silica does not react with ordinary clay because ordinary clay already has in chemical combination all the silica it can take up. But take the case of a few typical impurities of clay. Silica, or sand, alone has a high melting point, but when silica and clay are mixed it will be found that the melting point is lower than that of either the sand or the clay alone. This is due to what is known as eutectic relation. If you mix them in all proportions you will find that in a certain mixture you get the lowest possible melting point of all mixtures and on either side of this mixture you will have a higher melting point. With fire clay and sand that point is about 22 per cent clay and 78 per cent sand or silica. This presumes that the silica is very finely ground. If the sand is very coarse grained the eutectic may be at some other point. Finely ground silica and clay react and melt at about 1600 degrees Cent. in the proportions mentioned. The melting point line is a smooth curve with no kinks in it.

The addition of lime to clay in various proportions will produce a jagged melting point line. Mixtures of lime and clay all have melting points lower than either lime alone, which is very high, or of clay. Add up to 15 per cent of lime to the clay and the melting point will keep on going down, but get up to 17 per cent and it will go up again. Then it goes down again and then up and down like saw teeth. Each apex indicates where a chemical compound is formed between the lime and clay and the chemical compounds have a higher melting point than the mixture. So you cannot say that if 2 per cent of lime will lower the melting point so much that 20 per cent will lower it 10 times that much. In determining the melting point of clay, the amount of free silica it contains is of more importance than the amount of what are commonly known as fluxes —potash, soda, lime and iron oxide.

Abstract of a paper read before the Pittsburgh Foundrymen's association. The author, H. F. Stahle, is a ceramic expert with the bureau of standards, Washington, D. C.

It is almost, if not altogether impossible to judge the melting point and the refractoriness of a fire clay by chemical analysis owing to the effect of the physical condition of the impurities—whether fine or coarse grained—and the fact that the state of the chemical combination of the ingredients is as important as the amount of impurities in the clay. The bureau of standards annually determines the melting point of hundreds of clays, but not by chemical analysis. The melting point of a clay is determined by melting it.

The bureau employs two methods in making the melting point test. One is by pyrometric cones. A small tetrahedron of clay is made up similar in shape and size to the standard pyrometric cones made by Professor Orton of Ohio university. A sample of the cone is placed in the center of the clay pad, around which are placed three or four cones and then put in a pot furnace and charged by a low flame, generally of natural gas and compressed air. If the flame is hot enough, the fire clay cone will bend over and at the same time one or more of the pyrometric cones will bend. If cone No. 26 bends over at the same time the fire clay does, the clay is rated as having the melting point of cone No. 26. These cones go down at certain temperatures, but not with much accuracy because the time to which the cones are subject to a certain temperature is a factor in determining whether they are going down; that is, a cone or a piece of clay will melt at a lower temperature if it is held at a certain temperature for a long time. If it is desired to melt the cone or the clay in a shorter time, it has to be heated at a higher temperature. So it is hardly fair to try to translate the melting point into degrees Cent.

The other way of testing clays is in an electric furnace. Clay is made up into small cylindrical pieces, put into crucibles and then in an electric furnace heated until the clay starts to flow around the edges. The heat is determined by use of an optical pyrometer and in this way it is possible to get the melting point directly in degrees Cent. Either method is satisfactory, but for foundry use the electric furnace has an advantage over the gas furnace in that in an electric furnace conditions correspond with conditions in most foundry operations under which clays melt, namely, reducing conditions, while in the gas furnace oxidization conditions prevail and if the clay contains any appreciable amount of iron it will stand a higher temperature under oxidizing conditions than under reducing conditions. Therefore, the vacuum furnace is likely to provide a more actual indication of the temperatures at which the clay will stand than the gas furnace.

How Bonding Power is Measured

The only other property which clay should have beside refractoriness, is bonding power. The bureau of standards determines bonding power either by tensile strength and direct power or by making a beam and cross-bending test and calculating the modulus of rupture. The latter factor alone is no very secure indication of its bonding power. Modulus of rupture increases by the addition of sand to very sticky clays which develop high cracks on drying and the sand causes them to dry better and have greater strength. If the amount of sand was increased to three or four times as much, the relations probably would be changed again. In testing clay for any particular use, the only method of determining whether it will be satisfactory is to actually test the clay in the particular mixture. In making the tests use clay in a mixture in the same proportions as it is used in the foundry.

The rate at which test bars are dried has a very decided effect. If they are dried carefully they will have high strength. And here is another point. After a bar is thoroughly dried, it does not change in strength, cross-bending or tensile, very much if it is heated up to 500 or 600 degrees Cent. Heating it up to the point where the water of chemical combinations evaporates has practically no effect on the strength of the clay bars. In making oil bound cores for dry-sand molds, the bonding strength of the clay is very important because some of the oil cores do not have any binding power left in a large part of the cores excepting that of the clay. All the molasses is burned out.

Improving the Luster on Nickelplated Stove Castings

By E. P. Later

QUESTION:—*We are experiencing difficulty in obtaining a good luster on stove castings which we nickelplate in our plant. We believe that the plating is too hard. What should we do to obtain a softer coating?*

ANSWER:—Without knowing more about the conditions under which the work is finished it is rather difficult to say definitely why trouble is being experienced in securing the desired luster on the nickelplated work. It is possible that the parts are not buffed sufficiently before plating, due either to lack of attention or to the use of an improper buffing compound; a highly buffed finish always demands careful preparation of the surface before plating. Lack of care, the use of an inferior buffing compound or one which is not suited to the work, may be the source of at least part of the trouble and it would be advisable to investigate these points carefully.

On the other hand, the nickel deposit may really be too hard and in that event the solution used is faulty in some respect; probably it is too low in metal content and of too high acidity. I would suggest that the amount of nickel in the solution be determined and, if necessary, enough nickel salts added to bring the metal content up to the figure called for in the formula which is used in preparing the bath. It would also be advisable to examine all of the anodes; possibly it will be found that many of them have been so reduced in size that the total anode surface exposed to the solution is less than the area of the average load of work plated. Under these circumstances it will be necessary to put in additional anodes; it is always desirable to have the total effective anode surface slightly greater than the surface of the parts which are being plated. Otherwise, metal will be taken out of the bath more rapidly than it is replaced by the solution of the anodes and the deficiency must then be made up by frequent additions of nickel salts.

Casting Direct From Blast Furnace

By H. E. Diller

Question:—Kindly give us information on the problem of making gray-iron castings with metal direct from the blast furnace, without the use of an intermediary cupola.

Answer:—This could be done only for unimportant castings where the quality of the iron is of little consequence, because the iron as it comes from the blast furnace will be of low strength. There is also probability of considerable variation in the silicon contents of the iron from one tap to the next, and the iron would frequently contain an excess of carbon which would come out as kish.

A plan might, however, be worked out by using a mixer into which the iron from the blast furnace could be treated—strengthened by the addition of steel scrap and the silicon raised if too low by the addition of ferrosilicon. This would also necessitate some means for keeping the metal in the mixer heated.

Pointers For The Patternmaker and Molder

Altering Design to Simplify Pattern Making—Scraping Metal Patterns on a Lathe—Chiseling and Finishing Recesses to Gage

A FEW lines, either straight or curved are easily made on drawing paper. However, when these are interpreted in the pattern shop and later the patterns have to be molded, a different condition arises. Those few lines sometimes so complicate the design that making the patterns and core boxes specified is almost impossible.

We have a draftsman who has only a smattering knowledge of pattern work and foundry practice. Although his experience is limited, he designs machine parts from which patterns are made and castings produced. Judging from the character of his designs, simplicity is never considered. I have just completed the pattern and nine core boxes for a four-way valve. This part has given the coremaker much trouble, and difficulty has been encountered in making the mold.

The accompanying illustrations, Figs. 1, 2, 3 and 4 indicate the way in which the job was originally designed and how it was changed to simplify its production. The body of the valve shown is 12½ inches in diameter. The bolting flange is 1½ x 14 x 14 inches and the four pads, *D*, *E*, *F* and *G* are six inches in diameter. The port openings are two inches in diameter and the ends of the ports which cut through the top of the valve are shaped and dimensioned as shown at *A*, *B* and *C*. The important details of this valve which were not subject to change were the shape, dimensions and position of the last mentioned ports.

The ports *D*, *E*, *F* and *G* were shown definitely located in the drawings which were sent to the pattern shop, but changes were made which did not influence the usefulness of the valve casting, but immeasurably simplified the cores.

There was no apparent reason for designing the port core *E*, *C*, *G*, as it is shown by the full lines, in Figs. 1, 2 and 3, and in the plan view in Fig. 4, and yet this was the way that it was planned. No designer who understood the principles of patternmaking would have so specified the port opening for the reason that the cores, the rods, vents, pasteing, and setting of such a core is not practical. There is no reason for the curves as shown. However, I did not allow the design to stand. I simply changed the cores to suit actual practice.

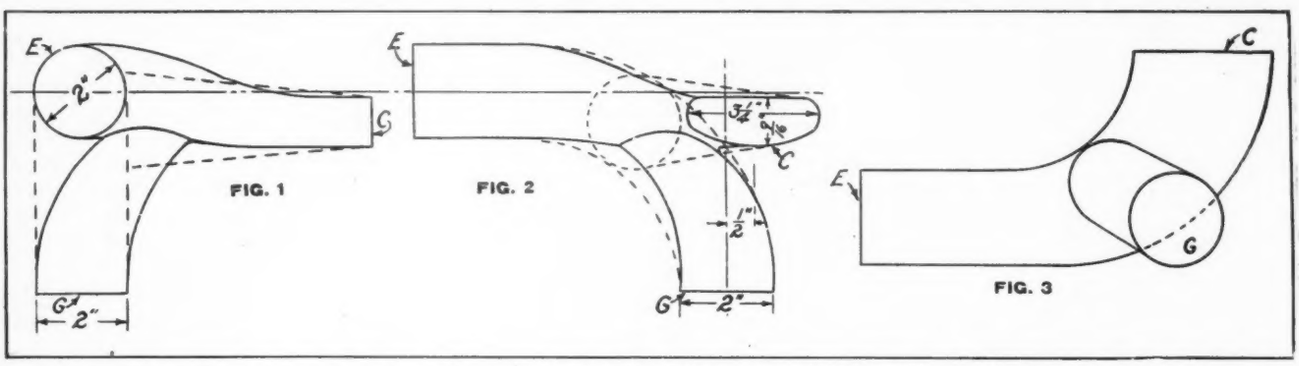


FIG. 1—END VIEW OF THREE-WAY CORE. FIG. 2—PLAN VIEW OF THE SAME CORE. FIG. 3—SIDE VIEW OF THE CORE. IN ALL THREE FIGURES THE FULL LINES SHOW THE ORIGINAL DESIGN AND THE DOTTED LINES THE MODIFICATION ADOPTED TO SIMPLIFY THE PATTERN WORK

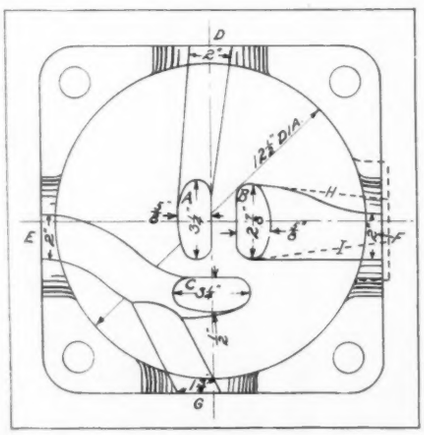


FIG. 4 — SKETCH OF THE FOUR-WAY VALVE SHOWING THE POSITION OF THE THREE-WAY CORE DESCRIBED

The altered design is illustrated in the dotted lines. I made the port, *E-G*, 2 inches in diameter with a quarter-round bend. Where the branch *C* left the other portion I made the diameter the same and tapered it to the opening. This simplified the core boxes and made an easier job for both the patternmaker and coremaker. The ports *D* and *F* were altered to the position shown in the dotted lines *H* and *I*. This made the two halves of the core box equal and avoided the eccentricity of the core as originally designed.

An error was made in the pattern, however, and was called to my attention by the molder. The pattern was molded with the ports *A*, *B* and *C* down. I made the core prints for these ports and also the side port prints at *D*, *E*, *F* and *G* two inches long, to hold the cores *up*. I should have made the side prints about 3½ inches long to hold the cores *down* and to secure them against the rising metal in the mold.

BY M. E. DUGGAN

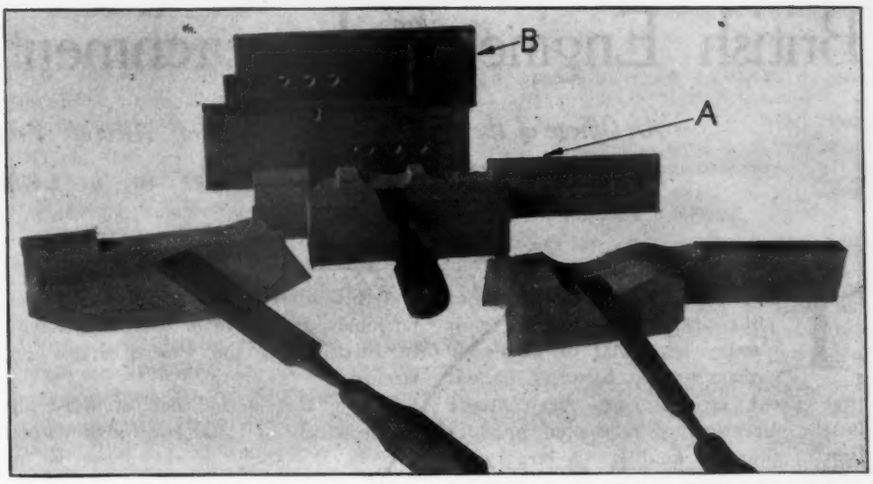
Scraping Metal Patterns on a Lathe

By W. S. Doxsey

In the pattern shop, as well as in any other branch of industry, the time saved and increased accuracy gained through the application of machinery to work usually performed by hand are certain to be reflected in an improved product and decreased costs. The use of an ordinary engine lathe for scraping a metal pattern is shown in the accompanying illustration, which is largely self-explanatory. One of the largest pattern shops in the country finds this method of scraping especially applicable to patterns with arc-shaped surfaces that cannot be machined in the customary manner due to the interference presented to the cutting tool by lugs, ribs, etc. Hand scraping such surfaces to the form of true arcs is a tedious and laborious process, which it is difficult to perform accurately.

The set up is made by clamping the

pattern on a face plate, centering the surface to be scraped in the usual manner. A wood handle of suitable length is bolted to the face plate in a convenient position for turning the work by hand through the required arc, and the lathe belt is slipped from its pulley. The scraping may be accomplished with the regular lathe tools, or if necessary, special ones may be ground to suit the peculiar characteristics of the pattern. The tool, clamped in the tool post, is fed into the work with the carriage and cross feeds as in ordinary turning. If desired, wooden blocks may be clamped to the ways of the lathe against which stops bolted to the face plate will strike, thus fixing the arc through which the work can be turned by the handle.



METHOD OF FINISHING RECESSES AND GAGING THE DRAFT ACCURATELY WITHOUT CUTTING TO LINES. HOW DIFFERENT LENGTH CORES ARE MADE FROM THE SAME BOX

Chiseling Recesses to Gage

By J. L. Gard

Difficulties which attend finishing recesses unreached by the plane are appreciated by every patternmaker. The writer has found the method shown in the accompanying illustration to be most practical. In the case demonstrated at *A*, a block is planed accurately to an even surface and with the proper draft which is to be used in the pattern part. This block then is placed beside the pattern part and may be clamped in position. The chisel then is laid flat and guided in cutting the recesses to a true surface. The same idea may be applied when a number of pieces are to be finished in curves and irregular lines that are duplicated. It also is valuable in attaining the same draft in similar pieces. It will be found much more satisfactory than the usual method of cutting to lines.

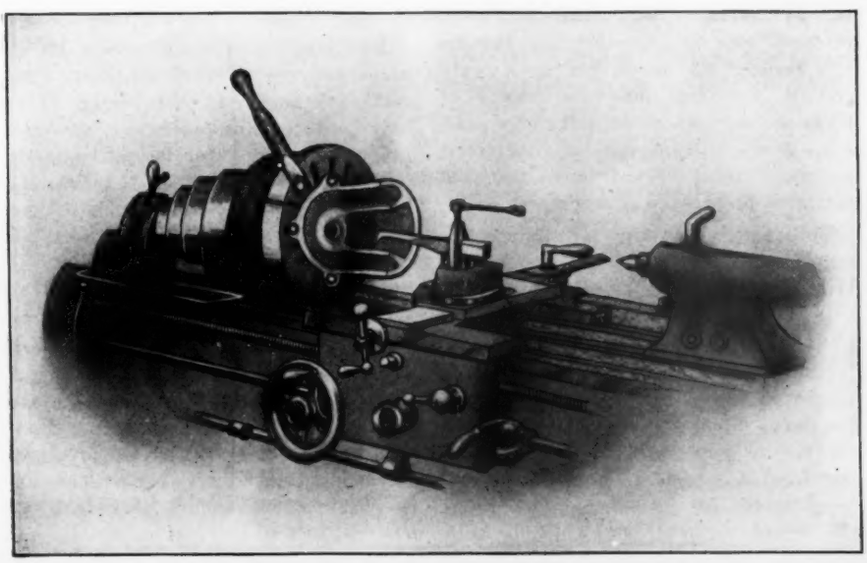
The box shown at *B* shows the manner in which a number of cores of the same section, but different lengths may be made from the same box. Here the bottom, one end and one side are fastened together. The opposite end and side constitute another unit which is grooved and fitted accurately along the lines where it joins the other portion. The holes shown in the sides accommodate dowel pins by which the length may be changed as desired.

Overcoming Cupola Bridging

By W. J. Keep

Question:—Our cupola bridges about 30 minutes after the blast is on and for about an hour the flow of metal ceases almost entirely. After that period the metal runs again and is hot and satisfactory. The cupola has a 60-inch shell and is lined to 42 inches. The tuyere area is one-fourth of the area of the lined cupola, the blast being furnished by a positive pressure blower which delivers 3000 cubic feet of air per minute. The bed extends 26 inches above the tuyeres and the iron charges consist of 1200 pounds of iron and scrap and the coke charges are 125 pounds each. Our coke contains approximately 12 per cent ash. We have never slagged our cupola, although it has been operating successfully without slagging for 15 years and we are unable to account for our present difficulty.

Answer:—You should light the cupola about two hours before tapping to insure raising the lining of the cupola to a temperature sufficiently high to melt iron when the first charge is made. It is evident that your fuel bed is too great and this must burn out before the iron reaches the melting point. It is dangerous, however, to reduce the amount of coke on the bed immediately. If your cupola is equipped with only one row of tuyeres, and if the coke extends from 15 to 18 inches above the tops of the tuyere openings, it would be much better than having it extend to a height of 26 inches. It would be advisable to reduce your bed 50 pounds of coke per day for several days, and if the iron is still sufficiently hot, an additional 50 pounds can be taken off until the point is just reached where any further reduction might result in dull iron. The tuyere area of your cupola seems large.



THE FACE PLATE IS PROVIDED WITH A HANDLE BY MEANS OF WHICH THE WORK IS ROTATED

The Lubrication Engineering Co. has been organized with a complete plant and laboratory to handle problems connected with lubrication. The purification and testing, as well as the design and installation of systems for handling lubricating, cutting and fuel oils and gasoline, will be undertaken by this organization.

The Cleveland office of the Chicago Pneumatic Tool Co., Chicago, has been removed from room 813 to rooms 406-408 Engineers building. Ross Watson is district manager.

British Engineer's Impeachment of Foundrymen

An Officer of the Technical Department of Aircraft Production Tells English Foundrymen About Their Shortcomings in the Light of His Experience

By Lieut A E Bush, R A F

IF we compare the state of the art of founding as it is today with that of 20 or 30 years ago, it becomes obvious that great strides have been made in the direction of increased production of superior quality. A large part of this progress is due to a greater appreciation of the advantages of the *open door* both literally and by the medium of the interchange of ideas, through the scientific and trade societies and the technical press. Our American friends probably have realized this to a larger extent than the foundrymen of England, for we are a conservative nation and tradition dies hard.

I have been surprised recently by the reluctance to impart information displayed by some of those holding responsible positions in the industrial world. Even the stimulus of war, in many instances, has failed to encourage them to divulge their store of knowledge for the use of their co-tradesmen, and the good of their country.

I am sorry to say that these remarks do not alone apply to foundrymen, but also to engineers, and it is to both classes that I address this appeal for a greater interchange of ideas and information. Secretiveness inevitably means stagnation and I am convinced that publicity means progress. Let me give an illustration. We have evidence that cast iron was known in Japan in the year 70 A. D., and in Italy a century later, but it is not until 1311 that we have any record of the manufacture of pig iron. This was in Westphalia, Germany; about 50 years later it is recorded that cast iron was first produced in Sussex, Eng. From this it appears that it took nearly 1300 years for the civilized countries of the world to learn how to produce cast iron in its crude form. The first record of the publication of information on the making of cast iron dates back to 1454. Immediately thereafter the art of cast iron founding rapidly developed and in 1516 a 5-ton gun was cast in London.

Ancient history thus emphasizes the beneficial results obtained by publicity as compared with the stagnation caused by secretiveness.

Coming down to recent times, we find that practically all the advance which has been made in modern foundry practice has occurred since 1880 and this progress has taken place simultaneously, and more or less independently, in England, the United States and Germany.

During this period has occurred the development of modern foundry machinery, the study of the properties of foundry materials and, in the more enlightened foundries, the classification of pig irons and castings by their analyses instead of purely by the appearance of their fractures. These changes have not occurred without entailing a vast amount of labor on the part of those earnest and unselfish men in the trade, whose names today are household words on both sides of the Atlantic. The average foundryman and foundry proprietor of one or two decades ago resisted the movement strenuously, and it was not until the efforts of those pioneers of modern foundry practice were instrumental in organizing societies among foundrymen that appreciable progress was made.

Today we have an added incentive to progress. Present-day foundries are being forced into quantity production with all its specialized processes and plant.

I now propose to consider how far the present products of the foundry fulfill the needs of the engineer, but I must ask you to remember that I am speaking from a somewhat biased and personal standpoint and that in all probability my views do not coincide with those of other engineers.

I propose to deal with the subject under the following heads:

The production of sound castings of correct size and shape.

The production of homogeneous castings of normal quality and of uniform properties.

The production of castings having special properties.

Considering first the production of sound castings of correct size and shape, I suppose there are few engineers who could not give instances in their experience of apparently simple castings which were not sound and free from draws, blowholes or other defects. Numerous other examples could be given of castings which were not correct to size or shape. Often the faults of such defective castings appear to the engineer to be due to a lack of that manipulative skill which every self-respecting molder's apprentice should aspire to possess, that is to say faults due to incompetence or carelessness on the part of the molder or coremaker. In some cases investigation seems to indicate that the faults complained of are due to neglect of well-known technical precautions. These include defects due to poorly placed runners, feeders, gates and risers; insufficient venting, incorrect ramming and slovenly pouring.

On the other hand, many of the apparently simple pieces give the foundry a vast amount of trouble which might be much reduced if the designers made a practice of calling into consultation the patternmaker and foundryman before finally settling the details of his design.

For instance, we might consider the numerous examples of castings appreciably oversize and overweight. These may be due to the practical impossibility of producing pieces of the thickness specified on the drawing, or, on the other hand, they may be due to the common lack of appreciation of the fact that the engineer does really intend his drawings to be worked to in all respects.

The patternmaker leaves his patterns a little oversize to insure a sufficiently thick casting and the molder takes care to rap it well to insure a clean draw, with the inevitable result of producing a casting appreciably overweight and oversize. In these days of weight saving this is a serious defect.

Although admitting that in many cases the engineer is to blame for not having

Specifications Are Absurd

This severe arraignment of English foundrymen and their practice, recently was delivered before the Birmingham Branch of the British Foundrymen's association at a meeting held jointly with the Coventry Engineering society, at Coventry, Eng. Lieut. A. E. Bush who delivered the address is affiliated with the technical department of British aircraft production. In discussing the difficulties that confronted foundrymen in meeting the requirements of the British Aircraft board, E. H. Broughall said that some of the specifications were jokes, while certain chemical analyses and tensile tests demanded were absurd.

consulted the foundryman before settling the details of his design, the adoption of one or more of the various precautionary measures which the founder has at his disposal would largely have prevented the production of scrap castings.

There are the other cases in which defective castings are due to improper melting and here we begin to enter the domain of the metallurgist. Metallurgical science has made vast strides in the last 20 years, but it does not appear that the founder has taken full advantage of this information. It should be understood that all foundrymen are not included in this allegation. In the majority of cases, however, too little attention is paid to the principles underlying the metal melting operations and the result is reflected in the high percentage of scrap produced.

Metal melting is a highly skilled operation and should be treated as such under the supervision of a trained metallurgist who is familiar with the purpose for which the castings are required. I believe that many of the troubles associated with castings having thick and thin sections, and with castings incorrect in dimensions due to peculiar contraction changes, would be obviated if the metal melting and mixing operations were carried out on scientific lines.

Let us consider the production of homogeneous castings of normal quality and of uniform properties. Here one feels tempted to say that such castings are rarely made. No doubt this is due to faulty design and by calling the foundry expert into consultation before the design was finally settled, much could have been done to eliminate these defects. On the other hand, there remain many instances in which the foundrymen have not exercised those resources of their art, such as suitable risers, feeders, grates and chills. In other instances, venting, ramming and pouring are at fault.

We now come to the production of castings having special properties. In this respect there appears to be a lamentable lack of appreciation of the needs of the engineer by many foundrymen. No doubt the engineer is largely to blame because he does not state his requirements in a sufficiently definite manner, but, with a few exceptions, the average foundryman appears to be absolutely incapable of working to a definite specification. This is a sweeping statement to make and no doubt I am laying myself open to severe criticism.

In attempting to find out why the average foundry is incapable of working to specification, one is forced to the conclusion that in the majority of cases it is due to a lack of knowledge of the properties of the metals used. In how many of the average foundries of this country do we find a capable metallurgist on the pay roll?

During the war an attempt was made by the branch technical department of the aircraft production of the ministry of munitions to get the foundries to work to definite material specifications, but, while one records with pleasure the whole-hearted co-operation of certain foundries, there is no doubt that in most cases the attempt was resisted by the foundries concerned. The founder did not appreciate that the more closely he fulfilled the requirements of his customers, the more would they entrust him with their requirements in the future, and in fairness I must say that in many cases the engineers also failed to realize the importance of definitely specifying their requirements.

Let me make it clear that I am not advocating the employment of the theoretical man to the exclusion of the practical man. Both are required and it is essential that they should each be experts in their own line and that they should be trained to work together, the one supplying what the other lacks.

Introduction of Labor-Saving Equipment

The introduction of molding machines and other labor-saving appliances has had a tendency to lower the standard of the skilled molder. Without the highly skilled molder the modern foundry manager cannot hope to turn out a high percentage of good work. Similarly, the tendency of the blast furnaces to supply pig iron to a fairly close analysis does not do away with the need for the highly skilled metal expert, backed up by an efficient physical and chemical laboratory.

Summing up the results of our investigations into the manner in which the present production of the foundries fulfill or fall short of the requirements of the modern engineer, we find that:

Accurate castings are not generally procurable.

Sound and uniform castings are difficult to obtain.

Castings having definite physical properties can only be purchased from a very few foundries.

We have found that the engineer also is to blame owing—

To his failure to consult the foundry experts before completing the details of his designs, and

To his failure to definitely specify the properties which he desires his castings to possess.

Having arrived at these conclusions, let us see what can be suggested to improve the present state of affairs in order that the present foundry products may more nearly fulfill the engineer's requirements.

The faults may be tabulated as follows:

Lack of manipulative and technical skill in the molding operations.

Lack of skill in metal mixing, melting and pouring operations.

Lack of co-operation with the engineer.

We will briefly consider these in this order. Latter-day competition has forced the foundry proprietors to install labor-saving devices of various kinds, such as molding and coremaking machines, and has further compelled them to go in for bulk production of specialized products. The result has been that many foundry proprietors have adopted the doubtful policy of employing a large proportion of semiskilled men, this being rendered possible by the automatic nature of the machines mentioned and the uniformity in the type of product turned out.

Provided that a sufficient number of highly skilled molders are to supervise the semiskilled men, no great objection can be raised to this procedure. In many cases, however, the management does not appreciate that while the routine operations are simplified by labor-saving devices, the difficulties involved in founding are just as numerous as ever and require the same amount of skill and experience to avoid large percentages of scrap. Therefore, specialty foundrymen do not provide the skilled men, nor do they take any steps to train their young labor.

In how many of our large foundries is there a comprehensive scheme of apprenticeship? What provisions are made by our educational authorities for imparting the principles underlying foundry practice to the molder's apprentice? We have been living in strenuous times, but we have just as strenuous times before us and it behooves us to be prepared to meet the world competition which we shortly will have to face. The government should shoulder its part of the burden to provide the necessary facilities for that portion of technical and trade education which cannot be provided by the employers.

The next point to consider is the lack of skill in the metallurgical operations. This only can be remedied by appreciating the fact that metallurgical operations can be satisfactorily carried out only when a skilled technical staff is provided and when that staff is adequately supplied with the necessary equipment. This applies to both foundry and laboratory. It is useless to attempt to run a modern foundry without a metallurgical laboratory and to try to do without is just as sensible a proceeding as to attempt to run an engi-

neering works without an engineering department.

We now come to the lack of co-operation between the founder and the engineer. This is a matter which is largely in the hands of the latter. So far as I can see, nothing but good can result from such co-operation. The absence of any comprehensive scheme of technical education prevents the young draftsman getting that insight into foundry practice which he should possess and, therefore, it is all the more necessary that the foundryman should be consulted in all cases. It should be the aim of every draftsman to avoid specifying sharp junctions, rapid changes of section, unsupported cores and other fruitful causes of defective castings.

The present tendency in design is toward the elimination of all superfluous weight, and there is little doubt but that this tendency will remain just as marked in the future. The development of aerial transport and the replacement of horse transport by motor trucks are indications of this, or perhaps I should say they represent the accomplishment of the first steps in this phase of engineering development.

Must Work to Specification

We then feel safe in asserting that if the products of the foundry are to be used to any large extent in the designs of the engineer of the future, it will be necessary for the foundry to produce castings in accordance with the definite physical specifications. That these specifications will call for higher physical values than those now produced by the average iron foundry is certain, and we are thus led to predict that scientific foundry control will be essential in order to produce castings to close physical specifications, and as these specifications will provide for high physical properties it will be necessary to study the relation of the physical and chemical properties of the metals used.

Therefore, close attention to the melting, pouring and cooling operations will be essential to obtain the physico-chemical conditions necessary for the attainment of the physical values specified by the engineer. To make use of the higher physical properties certain to be specified it will be essential that the castings are so well made that they will be free from blowholes, draws and other defects, in order that the finished casting may develop its full strength in all parts and thus allow of the greatest possible saving in weight.

The question of the price of the finished product will be of vital importance in the future and, therefore, the engineer will try to eliminate all needless machining. This only will be possible if the founder produces castings correct to size and shape and having a fine finish. This indicates the desirability for the use of an alternative material for the molds from that at present employed, which will be less likely to be deformed, and, as the quantity of pieces required will in all probability be large and competition keen, we may have to consider the question of metal or other permanent molds.

Considering the difficulties attaching to the production of sound castings at low cost, we may expect to see great impetus given to methods of casting which permit the use of metals containing high percentages of impurities, such, for example, as the use of the electric furnaces for refining impure metals, or the use of centrifugal casting processes to insure the segregation of the impurities in portions of the casting which are ultimately removed from the finished article.

In addition to the general requirements just indicated, one might suggest various special metals for which there will be a certain demand. These include special irons for the cylinders and pistons of air-cooled engines. These will have to have the special properties of ordinary cylinder irons and, in addition, the metal will have to remain stable under high temperature conditions. Those of us who have had experience with air-cooled engines, know that the present types of irons are liable to high temperature changes. Sometimes the defect reveals itself in a decrease in the strength of the metal and at other times the tendency of the metal to grow. This affords a wide field for development.

Making Steel Castings

So far I have omitted any mention of steel castings. This is not due to any lack of appreciation of the suitability of steel castings for many purposes. However, I want to suggest to foundrymen who have installed, or who propose to install, plants for the production of steel castings, that they should investigate the possibility of producing a range of steel castings of compositions analogous to those of the various structural steels now in common use. The possibilities of alloy steel castings also might be investigated. The foregoing remarks bring us to the subject of heat-treatment of castings, and here I think the foundry metallurgist has an unlimited field for experimental work. The study of the heat-treatment of steel is still in its infancy. I have no doubt but that the requirements of the future will compel more attention be paid to this subject.

As has been stated, the tendency of design in the future will be toward weight-saving and the engineer looks with longing eyes to the light alloys. On numerous occasions we have had our hopes raised by announcements of the discovery of a wonderful metal which has the strength of alloy steel combined with the lightness of aluminum, but we are still awaiting its arrival. The use of light alloy castings, in many instances, will be limited by their unsuitability to withstand abrasive action and, therefore, we may reasonably expect that the sphere of usefulness of this material would be very much enlarged by the evolution of a really satisfactory method of casting-in suitable bearing metals, or by some process of improving the resistance to wear of the light alloy itself.

The further development of die-casting methods may be expected in the near future and this may greatly increase the usefulness of the light alloys, as also may other methods of consolidating the material such as subsequent stamping or hammering operations.

Requirements Summarized

Summarizing the requirements of the future engineer, we find these to be as follows:

Castings produced to close physical specifications.
Castings of high physical properties.
Castings sound and free from defects in all parts.
Castings correct to size and shape and having a fine surface finish, preferably produced in permanent molds.
Castings produced at low cost by refining processes which produce good castings from cheap raw material.
Castings having the properties of steels by so arranging the casting conditions that the impurities are rendered inert or nonexistent.
Castings produced from light alloys, having strength and other properties approximating to those of steel.
Castings produced from light alloys, but with bearing or other surfaces possessing special properties suitable to the needs of the design, obtained by casting-in, chilling or local hammering.
Castings produced by die-casting processes, close to size in order to eliminate subsequent machine work.
Castings having special properties for special purposes.

In considering the future needs of the engineer, I have purposely avoided discussing the technical details of foundry development as being outside the scope of the present subject, but there is no doubt in my mind that much remains to be done before the products of the foundry of today would fulfill the requirements of the future. When one considers the variations which exist in the properties at different portions of such a simple casting as a piston ring pot, it is obvious that an enormous amount of development work remains to be done in the domain of practical foundry technology. Even more so is this true when one considers the merits, or otherwise, of such sub-

jects as top and bottom pouring, methods of venting, running and gating, local chilling, methods of ramming, types of cores, etc., not to mention furnaces and cupolas.

Also, I want to direct attention to the need for the standardization of test pieces and methods of mechanical testing, and for the standardization of methods of sampling for chemical analysis. The methods at present in use by the various foundries that carry out such tests are far too diverse to afford any reliable comparison to be made. It is also essential to the better understanding of the properties of the materials used, that the variety of tests employed should be as wide as possible, but in each case the conditions of the tests should be strictly recorded.

Having now suggested the line of development which may be necessary in the future, it only remains for me to state that the requirements of the present can best be met by the foundries that take immediate steps to render it possible to fulfill those needs by the provision of:

Adequate modern foundry equipment.
The employment of a sufficient number of skilled foundrymen as assistants and foremen.
A skilled technical staff backed up by an adequately equipped physical and chemical laboratory.
A comprehensive system for close co-operation with the engineers and designers to the mutual benefit of both.
The training of apprentices.

In concluding this admittedly one-sided statement of my views on the foundry from an engineer's point of view, I should perhaps apologize for the comments which I have made on the capabilities of the foundries, but I must claim your indulgence on the ground that I have only voiced my opinions as drawn from past experience, and if that has been unfortunate, perhaps other engineers will assure the founders that their experience leads them to other and different conclusions.

New York Foundrymen Discuss Training Problem

AN organized movement for the training of foundry apprentices was announced at a recent meeting of the Associated Foundry Foremen of New York and vicinity. C. C. Schoen, superintendent of the training and dilution service of the United States department of labor, also connected with Yale & Towne Mfg. Co., Stamford, Conn., outlined the steps being taken by the training service to further the movement, and appealed for full co-operation of the management of the foundries in the New York district.

Training is Needed

While the problems are large, necessitating the full support of the foundries throughout the country, Mr. Schoen believes that much can be accomplished in eliminating the serious labor situation confronting the average foundry owner, through the limited training opportunities offered. He stated that during the war more than 200 organized training departments were established. The machine tool industry, he asserted, has taken the lead, and at the present time the shoe, rubber and similar industries are doing much in the matter of training apprentices.

Mr. Schoen stated that the old method of apprenticeship, whereby the apprentice was allowed to drift along for many months doing menial duties, and finally was permitted to work with the journeymen and absorb their knowledge, in many cases was of negative value. He contrasted this with the present-day plan of apprenticeship training under which the applicant is examined for his physical and mental capacities, and then is subject to a trial period to determine his fitness. If found acceptable, he is indentured and morally bound by agreement and put on production work. As he develops he is promoted according to a definite schedule. Shop work is supplemented by instruction. In addition, the apprentice's progress is checked and recorded, and in some plants he is rewarded according to his merit and accomplishment.

In the foundry field, the situation is somewhat different. The novice, it was stated, is employed not as an apprentice in most foundries, but is taken on as a laborer, and at a laborer's wage.

It was pointed out at the same time, that it is difficult to obtain foundry apprentices. The average American boy, it was asserted, apparently seeks other lines of endeavor, and the foreigner has to be relied upon to a large extent. It was generally agreed that much could be done to make the foundry more attractive to the younger generation.

Urges Exchange of Ideas

L. H. Steele, a foundryman of many years experience assisting Mr. Schoen, stated that in order to make organized training for foundrymen a success, it was necessary that the results of methods already tried should be known. This brought out several interesting suggestions and personal experiences from foundrymen at the meeting.

One plan used with considerable success in a large New England foundry proved of special interest. At the plant in question, 18 to 20 novices assemble daily during the noon hour to discuss problems pertaining to the trade. This at first was ridiculed by journeymen. Later, however, they, too, became interested, and the attendance at these classes has run up to more than 100. A course was established later which met two hours a night twice a week. The subjects covered were as follows: Cupola practice, blending of sands, reading of drawings, mixing by analysis, short cuts and foundry appliances. It was the thought of the meeting that such a plan would not prove practical in the smaller plants where there are not more than two or three apprentices or novices.

Hardness of Alloys Investigated

In studying the hardness of alloys, P. Ludwik, of Vienna, used the Brinell method, and the results of his observations were to the effect that the addition of 1 per cent of tin to copper increased the hardness of this metal 10 per cent, and 15 per cent of tin raised the hardness 300 per cent. Annealing the bronzes, it was determined, has little effect on their hardness. The addition of zinc to bronze increases the hardness somewhat. The addition of small quantities of zinc to copper increases the hardness slightly, but the hardness curve rises suddenly with 35 per cent of zinc. The hardness of brass is increased by tin and aluminum, but the brass is then brittle unless annealed. Nickel hardens copper less than aluminum or tin, but manganese has an effect between that of nickel and tin. Lead and bismuth soften copper. The hardness of tin can be increased to twice that of the original value by adding 15 per cent of lead, but more lead has a softening effect.

The Republic Creosoting Co., Indianapolis, has established branches in Buffalo, in the Erie County Bank building, and in the Hammond building, Detroit. George C. Beals is in charge of the Buffalo office.

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How Are You Going to Keep Him?

A FEATURE which cannot but impress those who visit different foundries throughout the country, is the increasing scarcity of boys on and about the foundry floors. Apprentices do not seem to be attracted to the foundry industry as they have in the past, and those who enter mechanical lines usually seek foundry experience merely as a stepping-stone to something else. Two agencies, our public schools and the foundries themselves have contributed to building up prejudice which blocks the path from the public school to the foundry. The woman-taught boy early receives a misconception of work in the casting plant. The foundry is represented as a smoky, dingy shed where dirty sand and dust compete with ever-menacing molten metal to make the life of the foundryman unbearable. On the other hand, the natural attraction founded on creative instinct which may be gratified through molding in sand, the charm of the alchemy which produces gears, cylinders, and a thousand different objects from blocks of iron and lumps of coke in the cupola would prove an irresistible incentive to boys if the subject were properly presented to them. But the reverse influence predominates. The whole attitude of those by whom a youngster is surrounded is apathetic if not antagonistic to this class of work. Some measure of blame for the existing condition, however, rests with the foundries themselves. Too often in the past an apprentice entering upon his work has had his hope of rapid advancement dashed by unending menial tasks and the proprietory attitude of those with whom he has worked. Foundrymen as a class are the most free to share with one another the learning of their craft. But too often this spirit applies only to those equally skilled in trade attainments and not to the apprentice boy at sea in strange surroundings, groping for information, self-conscious, backward and bound by the fetters of the most sensitive age. Those who work in the plant have not the time to bother with boy psychology. The overburdened foreman or superintendent can seldom supply the personal touch, that interest in the boy's progress which produces results and keeps him in the trade. Also to the higher officials he is too often the most insignificant item in the establishment. This attitude should be reversed. In England the problem of the boy in industry became so acute that many larger establishments appointed supervisors whose duty it was to supply the necessary personal touch, and to build up interest and incentive among the apprentice boys of the shop. The supervisor's duties largely were those of teacher and next friend. He supplied the personality through which the boy became interested in his employer. He developed a course of study which when followed to its conclusion acquainted the apprentice with the details of all foundry work. Shop courses similar to those which are used extensively in many industries in this country were placed at the service of the foundry boy. In this way he obtained a knowledge of his work and an appreciation of its worth to him. The supervisor system would not be feasible in this country except in the largest plants. The fundamental principles, however, involving an interest in the foundry boy, and an intelligent presentation of the industry and its opportunities through the schools might well be brought about through the independent but concerted action of foundry leaders.

Trade Outlook in the Foundry Industry

AUTOMOBILE manufacture, under which may be included tractor, truck and passenger car building, continues to furnish the greatest flow of business upon which foundries are operating. The tractor branch is the least active of the automotive trinity, due in some measure to the seasonal atrophy in agricultural channels. The widening gap between orders received and delivery schedules in almost all of the truck and passenger car plants and the steady pyramiding of inquiries are the best guarantees that this source will continue to furnish a large amount of work for foundries for months to come. The influence of this demand extends widely, reaching into nonferrous lines, and into plants which build tools in demand for automobile production. Second as a sustaining factor in foundry operation is building construction. Although hampered by high labor and material costs, continued congestion in the centers of population is forcing the erection of all classes of buildings and is inducing activity in the demand for domestic castings, furnaces, stoves, and eventually this will spread to municipal supplies. These alone of the main sources of demand for foundry output have remained unaffected by the industrial paralysis attendant upon the reluctant loosening of federal price-control.

Prices of Raw Materials for Foundry Use

CORRECTED TO MAY 9

Iron		Scrap	
No. 2 Foundry, Valley	$26.75	Heavy melting steel, Valley	$15.75 to 16.25
No. 2 Foundry, Birmingham	26.75	Heavy melting steel, Pittsburgh	15.50 to 16.00
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	15.50 to 16.00
No. 2 Foundry, Philadelphia	30.65	Stove plate, Chicago	17.50 to 18.00
Basic, Valley	25.75	No. 1 cast, Chicago	22.00 to 23.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	21.00 to 22.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	20.00 to 21.00
		Car wheels, iron, Pittsburgh	22.00 to 23.00
Coke		Car wheels, iron, Chicago	20.50 to 21.50
Connellsville foundry coke	4.50 to 5.00	Railroad malleable, Chicago	17.50 to 18.00
Wise county foundry coke	6.00 to 6.50	Agricultural malleable, Chicago	16.25 to 16.75

Gray Iron Recovering

Gray iron shops which never were overwhelmed with war work, did not experience the sudden shock succeeding the armistice. However, during the past few months a steady increase has been noted in practically all gray-iron casting lines. Some shops, fortunately situated in their facilities, can command more orders than they can handle from the automotive industries. Heavy shops handling machine tool work look for an early revival of both domestic and foreign orders to bring them business. The cancellation of approximately 2,000,000 tons of steel and 1,500,000 tons of wooden ships has caused a cessation in marine casting work in many foundries, but the approval of a new construction program based upon the report of a board of experts to the Emergency Fleet corporation is expected to bring back much of this demand. It is believed this report will be presented and acted upon by congressional committees early in the extra session, which is called for May 19. Stove and furnace work continues to improve, while the activity in various industrial lines continues to furnish orders for heavy furnace castings. Long neglected municipal improvements requiring manhole castings, and sewer and waterworks appurtenances are expected to supply much work during the early summer, although cast-iron pipe demand is light at present. Considerable foreign demand for cast-iron pipe is said to be held back by the shortage of shipping. Some southern makers are reported using No. 1 cast scrap purchased from dealers to the exclusion of pig iron in the manufacture of pipe.

Malleable Is Sluggish

Malleable operations which are dependent upon the automobile field continue active. The shortage of railway demand constitutes a handicap, which it is hoped will be removed with the adjustment of the price squabble in steel lines. Malleable plants are working between 65 and 70 per cent of capacity. Little in the way of new business was developed through the drop in price last month. It is generally thought that lower prices on malleable castings may not be expected soon, as about 50 per cent of the cost of production is in labor and no reduction has developed in this item. Agricultural implement manufacture continues slow, despite glowing crop expectations and the undoubted prosperity in rural districts. The flow of labor from the country to the city during the war is expected to reverse by midsummer. This, it is thought, will have an influence on the implement demand, as the sale of this class of equipment is directly proportional to the labor available to operate it. Foreign orders no doubt are held back both by the shortage of ships and the high freight rates. The impetus which is sought for foreign trade in general will no doubt be reflected upon the implement demand and thence to the malleable foundries.

Nonferrous Inactivity

Trailing closely with the other casting branches, the nonferrous foundries are experiencing the same changeable fortunes. Those associated with the automobile branches are active. The demand for pipe fittings, plumbing accessories and kindred brass appurtenances is increasing. The dearth of car and locomotive construction has limited production in many shops to a minimum. Casting copper is quoted at 15.25c to 15.37½c New York. Prices on other nonferrous metals based on New York are: Lead, 5c; tin, 72½c; antimony, 6¾c; aluminum, No. 12, alloy, producers price, 31½c, and open market, 26c. Spelter is quoted at 6c, St. Louis. The monthly comparison of March and April price averages follows:

	Copper	Lead	Spelter	Antimony	Aluminum
March	15.91	5.25	6.186	6.80	25.67
April	15.39	5.06	6.189	6.69	25.33

Steel foundries in general are optimistic though experiencing an extremely slack period. Tractor and truck manufacturers are furnishing a steady demand, but the great volume of work depends upon the railway and industrial plant construction.

COMINGS AND GOINGS OF FOUNDRYMEN

W. D. Ball, of Detroit, has been placed in charge of the contract department of the Wilson Foundry & Machine Co., Pontiac, Mich.

J. H. Deppeler, of the Metal & Thermit Corp., Jersey City, N. J., recently was elected a director of the American Welding society.

O. D. Conover, formerly chief engineer of the T. W. Price Engineering Co., has accepted a position with the Austin Co., Cleveland.

C. F. Cowic has been appointed district representative for the National Grinding Wheel Co., Inc., Buffalo, with offices at Cleveland.

Alexander C. Brown, president of the Brown Hoisting Machinery Co., Cleveland, reeently was elected second vice president of the Cleveland chamber of commerce.

L. F. Caproni, formerly with the Bethlehem Steel Co., New York, has accepted a position in the sales department of the Hay Foundry & Iron Works, New York.

H. L. Ritts has resigned as sales engineer for Young Bros. Co., Detroit, to accept employment in a similar capacity with Holcroft & Co. of the same city.

Harry A. Stander has been discharged from the navy and has resumed his former position as production manager of the Damascus Bronze Co., Pittsburgh.

C. W. Clauser, who was formerly purchasing agent for the Marseilles works of Deere & Co., at East Moline, Ill., has been made purchasing agent for the Maytag Co.'s foundry in Newton, Iowa.

Dr. Paul D. Merica, who has been with the metallurgical division of the bureau of standards, Washington, now is physical metallurgist in the research department of the International Nickel Co., Bayonne, N. J.

Victor E. Rehr, formerly sales manager of the Trumbull Steel Co., Warren, O., now is general manager of the Aetna Foundry & Machine Co., also of Warren, O., in which he has secured an interest.

Stanley P. Stewart, formerly mechanical engineer for the Stewart Boiler Works, Worcester, Mass., has accepted a similar position with the Bass Foundry & Machine Co., Fort Wayne, Ind.

Allan E. Goodhue has been made managing director of the Consolidated Pneumatic Tool Co., Ltd., London, with plant at Fraserburg, Scotland. This is the English subsidiary of the Chicago Pneumatic Tool Co., Chicago.

George N. Jeppson, works manager of the Norton Co., Worcester, Mass., has been appointed by the governor of Massachusetts as a member of the new commission on foreign and domestic commerce.

Charles L. Newcomb, general manager of the Deane Steam Pump Co., Holyoke, Mass., a branch of the Worthington Pump & Machinery Corp., and president of the New England Foundrymen's association, recently celebrated the thirty-eighth anniversary of his connection with company.

Charles F. Herman, formerly foundry superintendent of the Waterloo Gas Engine Co., Waterloo, Iowa, has resigned to accept a similar position with the Flint, Mich., plant of the General Motors Co. He entered on his new duties on May 1.

T. J. Hudson recently was made acting manager of the pneumatic tool sales division of the Chicago Pneumatic Tool Co., Chicago, to succeed F. H. Waldron, who has been made Minneapolis district manager for the company.

J. G. Lude has been made assistant general manager of the Lewis Steel Products Co., Toledo, O., makers of gray and malleable iron castings. He was director of purchases of the Falls Motors Corp., Sheboygan Falls, Wis., for the past six years.

Oliver D. Conover who is associated with the Austin Co., Cleveland, in its Philadelphia office addressed the Philadelphia Foundrymen's association at its meeting on May 7. The subject of foundry design and construction was covered and fully illustrated by lantern slides.

John Jeppson, superintendent of the Norton Co., Worcester, Mass., celebrated the fiftieth anniversary of his arrival in this country on April 25. Arriving as the fifth Swedish settler in that city, he became identified with the Norton Co. as its superintendent upon its organization, in 1895.

Thomas H. Spragle, recently discharged from the Rainbow division upon his return from service overseas, has resumed his duties as purchasing agent and chief of the traffic department of the Standard Process Steel Corp., Phillipsburg, N. J., manufacturer of iron and steel castings, gears, etc.

H. F. Stahle, of the bureau of standards, Washington, was the speaker at a recent dinner of the Pittsburgh Foundrymen's association. He presented an interesting paper on clays, touching on the origin, kinds and classes best suited to the various foundry uses, as determined by the government's investigations.

Stewart Johnston, president of the Pittsburgh Steel Foundry Co., Pittsburgh, has been elected a director of the Real Estate Trust Co., that city.

August Johannes, who for 12 years has been employed in aluminum plants at Two Rivers, Wis., has been made manager of the new works of the

Our New Boston Office

In order to serve its rapidly-growing interests in New England more adequately The Penton Publishing Co., publisher of THE FOUNDRY, *has established a new branch office in Boston. This office is located at 426 Old South building, 264 Washington street. It is hoped that the foundry and allied interests of New England will make use of its facilities freely. The foundry industry is unusually well developed in New England, there being 170 foundries in Connecticut, 44 in Rhode Island, 275 in Massachusetts, 24 in Vermont, 37 in New Hampshire and 43 in Maine, making a total of 593 for the New England states. The New England office will be fully organized in both editorial and business departments. The editorial work will be in charge of H. R. Simonds. During the war Mr. Simonds was captain of Company F, 317th Engineers, attached to the First Army corps, American Expeditionary Force. He also brings to his work a broad engineering training. The business department will continue to be in charge of Paul R. Fisher, who has heretofore made his headquarters in New York. The Penton Publishing Co., Cleveland, also publishes* THE IRON TRADE REVIEW, THE DAILY IRON TRADE AND METAL MARKET REPORT, THE MARINE REVIEW and POWER BOATING, *and in addition to the new Boston office maintains branch offices in Chicago, Cincinnati, New York, Philadelphia, Pittsburgh, Washington, D. C., and Birmingham, England.*

Badger Aluminum Co., Sheboygan, Wis.

Capt. Charles B. Carter, recently discharged from the mobile ordnance repair corps in France, has been elected an honorary member of the Chicago Foundrymen's club. He was the only member of that organization to see military service. Since his return he has become affiliated with the sales department of the Chicago Steel Foundry Co.

Pneumatic-Draw Rollover Core Machine

The accompanying illustrations show a pneumatic-draw, hand-power rollover core machine recently developed by the E. J. Woodison Co., Detroit. This machine is designed to handle deep, difficult cores as well as plain simple ones. It may be operated by inexperienced labor or by girls and has been developed mainly with the idea of relieving the operator of the heavy lifting involved in rolling over and drawing deep heavy core boxes. Briefly described it is a coremaker's bench provided with a clamping device to hold the box in the air while it is being rolled over and also equipped with a pneumatic arrangement for drawing the box off the core. A satisfactory drawing device, of course, is a most important feature of any core machine.

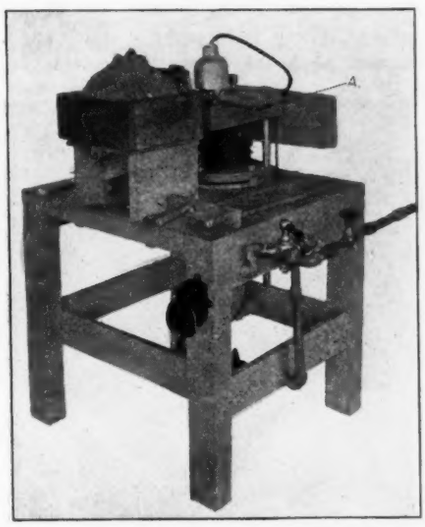


FIG. 1—CORE BOX READY FOR RAMMING

Fig. 1 shows the corebox in place filled with sand ready for ramming. In Fig. 2 the core has been rammed and hangs suspended and partly rolled over. The rollover device consists of a shaft held in a clamp or vise which travels with the plunger of the machine. This clamp can be locked or unlocked by a quarter turn of the hand wrench shown at *A*, Fig. 1. The free end of the shaft carries an angle-shaped frame to which the core boxes are attached.

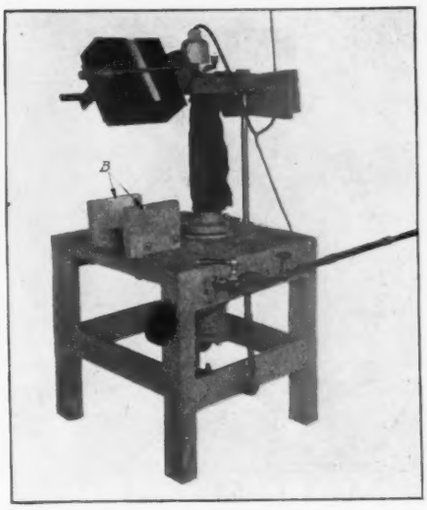


FIG. 2—CORE BOX RAISED AND PARTLY ROLLED OVER

The clamp is left unlocked until the core box has been rolled over and replaced on the stand *B*, Fig. 2; then the shaft is locked, the clamps are removed and the box is vibrated electrically using a knee switch. Finally air is admitted to the cylinder and the box is drawn off straight and true as it appears in Fig. 3. The machine is designed to handle core boxes up to 16 inches wide, 24 inches long and 12 inches draw.

To Build Electric Steel Foundry

An electric steel foundry, equipped with a 1-ton electric furnace, will be built at Lynchburg, Va., by the Southern Electro Steel Co., Inc., Scott building, Lynchburg, which was recently organized with $200,000 capital. The company is now taking bids on foundry equipment, including a 1-ton furnace, core oven, drying oven, annealing oven, heat-treating plant, sandblast equipment and traveling crane.

Officers of the company are: President, J. N. M. Keyzer; vice president, A. P. Montague, and secretary-treasurer, W. W. Ruble. The directors are: G. O. Lee, F. E. Turner Jr., N. A. V. Paulson, J. N. M. Keyzer, A. P. Montague and W. W. Ruble.

PORTABLE SAND SIFTER FOR USE WITH CURRENT FROM A WALL PLUG

Light Sifter is Motor Operated

The accompanying illustration shows a sand sifter built to operate on current supplied through an ordinary lamp socket connection. This device which is manufactured by the Schroeter Engineering Co., Chicago, may be suspended at a convenient height, and the length of drop cord stretched to a nearby wall or drop connection and set to work. An ordinary riddle is held in place by clamps on the hollow frame shown. A motor which is rigidly, but eccentrically set on the frame imparts an oscillating or gyratory motion to the frame and throws the sand in the riddle toward the rim. The three horizontal support members of the frame circulate a current of air and conduct the heat away from the motor. This action is aided by the descending sand as it falls from the riddle. The motor is enclosed to exclude the dirt from all moving parts, and is supplied for either direct or alternating current, and for the customary ranges of voltage as specified.

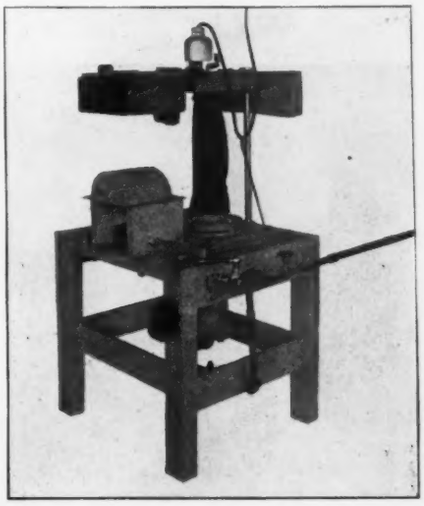


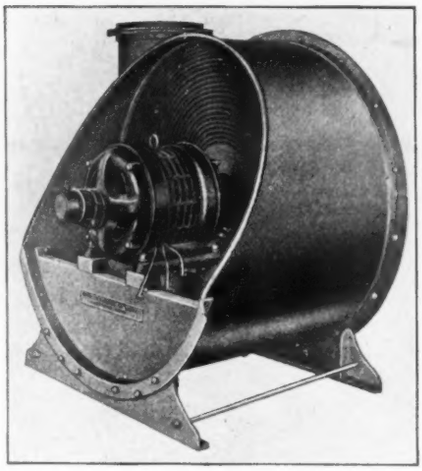
FIG. 3—CORE BOX DRAWN AND CORE READY FOR OVEN

Young Bros. Co., Detroit, has opened an office in the Engineers building, Cleveland. W. C. Wagner is in charge.

Using Heat Resisting Cement For Ladle Linings

An increase in the life of ladle linings is said to have been achieved during the past few years at a large number of casting plants throughout the country by substituting high temperature resisting cement for fireclay in laying firebrick. One of these plants is the Connecticut Electric Steel Co., Hartford, Conn., manufacturer of electrical steel castings. When using firebrick built up with fireclay, the company's ladle linings lasted, on an average, four weeks. For the past year or more this plant has employed a cement, manufactured by the Quigley Furnace Specialties Co., 26 Cortlandt street, New York, for lining and surfacing its ladles both for basic and acid open-hearth steel. The cement, it is stated, has increased the life of the ladle linings to six to eight months.

High temperature cement may be used also in gray iron plants, as shown by the record reported at the Barnes Foundry Co., Jersey City, N. J. Fig. 1 shows a thin wash of cement and water being applied to the inside surface of a 1-ton ladle at this plant after laying the bottom with firebrick. This coating air-sets without the application of heat, and serves as a binder between the metal and the lining. A mixture of equal parts of the cement and fire sand or other refractory, with enough water added to make the mixture plastic is then laid to the desired thickness, and the surface again washed over with the diluted mixture of cement and water. Fig. 2 shows the finished lining with the cupola spout lined in the same manner. A reasonable time for air drying is allowed before the ladle is preheated. During operation, some of the thin outside coating comes off with the slag where the latter is barred off but this does not disturb the lining which clings to the ladle wall. To repair this slight damage it is necessary to wash over the surface with the diluted mixture. Fig. 3 shows the condition of a 1-ton ladle lined in this way which was said to have had handled more than 120 tons of metal in 600-pound charges. The life of these linings averaged two months as compared with about one week to 10 days when fireclay alone was used.



MOTOR END OF TURBO-COMPRESSOR

FIG. 1—APPLYING A THIN WASH OF CEMENT TO ACT AS A BINDER BETWEEN THE METAL WALL AND THE LINING

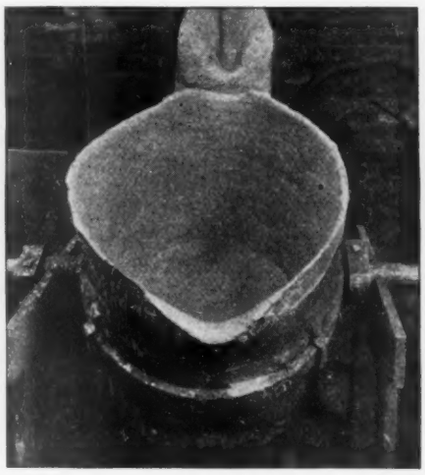


FIG. 2—LADLE AND RUNNER LINED WITH MIXTURE OF HEAT RESISTING CEMENT, AND READY FOR DRYING

FIG. 3—AFTER CONTINUOUS SERVICE, HANDLING OVER 100 TONS OF IRON IN 600-POUND CHARGES

Charpy Impact Testing Machine Now Made in America

Owing to the difficulty in importing Charpy Impact Testing machines from France, Sauveur & Boylston, Cambridge, Mass., have arranged to have these machines made in America, and will act as distributors. At present only one size machine is being built. This is the size which corresponds to the 30-kilogram French machine. The design of the Charpy has been generally followed, but a few changes have been made in the interest of simplification and improvement. A blue print is furnished with each machine giving the dimensions of the standard test piece as prescribed by the International Association for Testing Materials. Tables can then be made up to determine the resiliency or specific work in the metric system or in foot-pounds.

New Style Turbo-Compressor For Cupola Blowing

The Spencer Turbine Cleaner Co., Hartford, Conn., has designed a turbo-compressor which is suitable for furnishing air for cupola blowing. It has been tried out in several foundries and is said to have proved successful. This turbine is a direct connected, self-contained unit, dispensing with belts, gears and chains. It operates at 1750 revolutions per minute, which is an unusually slow speed for this type of machine. These facts make it quiet and it cannot be heard more than a few feet away when running under full power.

The accompanying illustration shows the motor end of one of the 1½-pound pressure compressors which delivers 1800 cubic feet of air per minute. The compactness of design is seen in this illustration which also shows the direct-connected motor.

The power consumption is said to be low at all loads but the special advantage of this machine is that the power consumption is directly proportional to the air delivered, so that it is practically as efficient under light volume as when working at its full capacity. It is provided with a Spencer adjustable blast gate by means of which the volume of air delivered can easily be adjusted and regulated. Two standard types of these turbocompressors are made. One delivers the blast at 1-pound

pressure and the other at 1½-pounds pressure. A number of sizes of each of these types have been designed, ranging in capacity from 600 to 10,000 cubic feet of air a minute.

Book Review

Inventor's Manual, by George M. Hopkins; cloth; 144 pages, 5 x 7½ inches; published by the Norman W. Henley Publishing Co., New York, and furnished by THE FOUNDRY for $1.25 net.

This book, compiled to meet the requirements of the individual possessed of ideas worth patenting, has entered its second edition. As the author states, it contains hints and information on patents generally and outlines approved methods for bringing them to public notice. The data have been revised and criticized by a firm of practicing patent attorneys to assure the soundness of advice relating to the legal phases of inventing and patenting. Guidance is offered to the seeker of a patent to protect him from excessive charges in securing his patent and marketing his invention. The various forms required in making application, assigning, licensing and extending grants are shown and safeguards in these cases are suggested. The subject of design patenting completes the book.

Joseph H. Bennett, previously associated with the El Paso, Tex., office of the Sullivan Machinery Co., Chicago, has been placed in charge as manager of the newly opened Mexico City branch of that company.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Windsor Foundry Co., Windsor, Vt., contemplates the erection of a modern plant, 80 x 200 feet.

Construction of a pattern shop will be undertaken shortly by the American Bridge Co., Philadelphia.

A site for a new plant recently was acquired by the Center Foundry Co., Wheeling, W. Va.

A building, 60 x 160 feet, will be erected by the Mueller Foundry & Fixture Co., Decatur, Ill.

Bids recently closed for the construction of a 100 x 200-foot brick foundry building for the Davis Foundry Co., Lawrence, Mass.

The plant of the American Beauty Stove Co., Erie, Pa., recently was damaged by fire.

The Atlas Foundry Co., Detroit, is installing a battery of core ovens at its plant.

The D. J. Ryan Foundry Co., Detroit, is equipping its plant with a battery of core ovens.

The Springfield Brass Co., Springfield, Vt., is reported planning to install an electric furnace.

H. C. White, F. A. Guernsey and L. F. Grimsely, Stockton, Cal., recently organized the White Foundry Co., which is capitalized at $50,000.

The Independent Stove Co., Owosso, Mich., recently let a contract for the erection of an addition to its foundry, 72 x 160 feet.

Erection of a brick, 50 x 60-foot foundry, will be started shortly by the Rockwood Sprinkler Co. of Massachusetts, Worcester, Mass.

Carl Gunterson, 1127 North Laramie avenue, Chicago, has awarded a contract for the construction of a foundry, 24 x 50 feet.

A contract has been awarded by the Philadelphia Sash Weight Works Co., Philadelphia, for the construction of a foundry, 60 x 144 feet.

A plant will be built at Jamestown, N. Y., by the Toscan Stove & Mfg. Co. James E. Toscan is president of the company.

The Standard Stove Works, Perth Amboy, N. J., has been incorporated with $100,000 capital, by Harris Edelstein, H. and J. Greenspan.

It is rumored that Maumee Malleable Castings Co., Toledo, O., is planning the erection of a plant addition.

Installation of 12 core ovens at the plant of the Nash Motors Co., Kenosha, Wis., recently was completed.

J. J. Tighe, 160 Twenty-fifth street, Brooklyn, N. Y., is reported planning the construction of an addition, 90 x 100 feet, to his brass foundry.

Plans are being prepared for the erection of a plant, which will include a foundry, for the Falls Mine Car & Equipment Co., New Galilee, Pa.

Holcroft & Co., Book building, Detroit, are installing 30 core ovens at the plant of the Wilson Foundry & Machine Co., Pontiac, Mich.

The foundry of the General Motors Corp. at Saginaw, Mich., is being equipped with 32 core ovens.

Two batteries of core ovens and 14 annealing furnaces are being installed at the plant of the Saginaw Malleable Co., Saginaw, Mich.

A 20-ton open-hearth furnace is being installed at the plant of the Monarch Steel Castings Co., Detroit.

Extensive additions recently were completed at the plant of the Chattanooga Roofing & Foundry Co., Chattanooga, Tenn.

Contracts for the construction of an addition, 160 x 240 feet, have been awarded by the Charles Bohn Foundry Co., Detroit.

Property, 270 x 720 feet, has been purchased by the Riverside Steel Casting Co., Newark, N. J., to be utilized as a site for a plant.

Contracts for the erection of a plant have been let by the Grand Rapids Brass Co., Grand Rapids, Mich. The building will be 92 x 100 feet.

A gray iron foundry, 72 x 200 feet, is being erected at the plant of the United Brass & Aluminum Mfg. Co., Port Huron, Mich.

It is expected the plant of the Central Foundry Co., Saginaw, Mich., will be in operation about Aug. 1.

J. Geigad, 346 Herman street, Buffalo, will let a contract for the construction of a foundry, 80 x 100 feet, for M. Hyman & Co., Buffalo.

Construction of an addition to its foundry is reported being contemplated by the Hanford Iron Works, San Bernardino, Cal.

A foundry addition, 40 x 80 feet, will be erected by the Iowa Steel & Iron Works, Cedar Rapids, Iowa, according to a current report.

A foundry addition, 20 x 24 feet, will be erected by the Muskegon Tool & Stamping Works, Muskegon, Mich.

Contracts have been let for rebuilding the plant of the Temple Malleable Iron & Steel Co., Temple, Pa., which was damaged by fire some time ago.

Plans for the erection of a machine shop and foundry are being prepared by the Owosso Bronze Bearing Co., Owosso, Mich.

A contract for the construction of a foundry, 52 x 115 feet, has been awarded by the Kuebler Foundries Co., Easton, Pa., of which William Kuebler is general manager.

The Akron Bronze & Aluminum Co., Akron, O., recently was incorporated with $50,000 capital, by Henry Elmann, Alfred Herberich, Edmund Burroughs and E. V. Smith.

The General Motors Corp. proposed expenditure of $2,427,000, provides for the completion of its foundry and motor plants at Saginaw, Mich., as well as the erection of a heating and power plant.

The Southern Foundry Co., Chattanooga, Tenn., which was recently organized by former Judge William Cummings and others, has started the erection of a plant.

The J. C. Wilson Mfg. Co., Ltd., Belleville, Ont., has been incorporated to manufacture castings and operate a general foundry, with $200,000 capital, by F. S. Wilson, H. A. Wilson and others.

Brass and aluminum castings are to be manufactured in a plant now being equipped by the Ajax Brass Co., St. Louis. Orville B. Baum is general manager of the company.

The Polish American Foundry Co., Buffalo, which was recently incorporated with $50,000 capital, will purchase equipment for a plant. S. Marciniak, 580 Amherst street, is in charge.

The Decatur Malleable Iron Works, Decatur, Ill., plans to issue $100,000 in common stock and $12,000 in preferred. The company will consider plant extensions later.

Work is expected to start shortly on the erection of a foundry, 60 x 115 feet, for the Michigan City Foundry Co., Michigan City, Ind. Contracts for the work were recently awarded.

The Buffalo Foundry & Machine Co., Buffalo, is reported having plans drawn for the construction of a foundry. Henry D. Miles is president of the company.

The Grand Central Machine & Brass Works, Inc., New York, recently was incorporated with $10,000 capital, by L. Gisser, E. Freidman and S. Dressler, 104 Second street, New York.

A recent New Jersey incorporation is that of the Near Steel Casting Co., Camden, N. J. The company is capitalized at $50,000. The incorporators are Thomas McAdoo, C. T. Eckert and others.

A pattern shop, machine shop and stamping and drawing shop is being installed in temporary quarters by the Badger Aluminum Co., Sheboygan, Wis., which was recently organized with $50,000 capital.

Founded as the North Side Brass Foundry, Chicago, the Hills-McCanna Co., 153 West Kinzie street, has been taken over by A. H. Noyes and A. A. H. Smith.

The Nickel Plate Foundry Co., East Cleveland, O., R. P. Chamberlain, 948 Engineers building, Cleveland, secretary, is taking bids for the construction of a foundry, 74 x 160 feet.

To finance the construction and equipping of additions to its foundry and machine shop, the Eagle Mfg. Co., Appleton, Wis., has increased its capital from $200,000 to $250,000.

The plant of the Tacoma Foundry & Machine Co., Tacoma, Wash., recently was damaged by fire. The loss has been estimated at $40,000. John Taylor is president of the company.

A recent incorporation is that of the Weldon

Machinery & Foundry Co., Weldon, N. C. The company has been capitalized at $25,000. Plans have not been announced.

The Keystone Foundry Co., Plymouth, Ind., has been incorporated with $10,000 capital. The incorporators are John E. Fogarty, George Pohl and D. P. Fogarty.

A meeting of the stockholders of the Pittsburgh Malleable Iron Co., Pittsburgh, will be held shortly to take action on a proposed increase in capital from $300,000 to $1,000,000.

Contracts for the construction of an assembling plant, 96 x 142 feet, have been let by the French Oil Mill Machinery Co., Piqua, O. The company is in the market for a used planer, 60 x 48 x 16 with four heads, and a 72-inch shell cupola.

Capitalized at $20,000, the Columbia Iron Works, Columbia City, Ind., was recently incorporated to manufacture general foundry products by Frank L. Meyers, Wallace W. Williams and Thomas L. Hildebrand.

Among the recent Indiana incorporations is that of the Bass Foundry & Machine Co., Fort Wayne, Ind. The company is capitalized at $1,700,000. The incorporators are: John H. Bass, Gaylord M. Leslie, Charles T. Strawbridge and others.

The H. D. Best Co., Flatiron building, New York, has the contract for designing, building and equipping a malleable foundry with a capacity of from 40 to 50 molders, for the Jefferson Union Co., Lockport, N. Y.

Plans of the Chester Iron & Foundry Co., St. Louis, which was recently incorporated with $25,000 capital, as yet have not been announced. The incorporators of the company are William Schaelich, Anna Schaelich and others.

Among the recent incorporations is that of the North Jersey Foundry Co., Patterson, N. J. The company is capitalized at $25,000 and was incorporated by Henry A. Breeland and Joseph T. Smith. Plans of the company have not been announced.

The Lloyd Garrett Co., 229 North Twenty-third street, Philadelphia, has acquired property from the National Galvanizing Co. The company recently filed plans for the construction of a foundry addition, 20 x 42 feet.

The Pattern & Castings Product Co., Saginaw, Mich., has been organized and will manufacture a general line of wood and metal patterns, brass and aluminum castings. J. C. Green is president of the company.

New additions to the foundry of the Cedar Rapids Foundry & Machine Co., Cedar Rapids, Iowa, will increase its size about 300 per cent. Besides the foundry addition an extension to the company's machine shop will be erected.

Further enlargement of the facilities of the Gerlinger Electric Steel Foundry and the Gerlinger Steel Casting Companies, Milwaukee, Wis., has been effected by the purchase of the woodworking plant of the Radcliffe Mfg. Co.

The Metal Studios, Ltd., Toronto, Ont., recently was incorporated to engage in business as iron and brass founders. The company is capitalized at $50,000. Samuel Nelson, Alfred Somerville and Joseph E. Payne are the incorporators.

Contracts have been awarded by the Dayton Malleable Iron Co., Ironton, O., for the construction of a core room. The space now occupied by the core room will be vacated, and a completely equipped pattern shop installed.

A recent Delaware incorporation is that of the Pennsylvania Die Casting & Mfg. Co. The company is capitalized at $100,000 and was incorporated by R. A. Piebles, East McKeesport, Pa., J. M. Vero, Munroeville, Pa., and F. H. Woumans, Wilkinsburg, Pennsylvania.

A recent Canadian incorporation is that of the Stickney Motors, Ltd., Peterborough, Ont. The company plans to conduct a general foundry and manufacturing business. It is capitalized at $1,500,000 and was incorporated by Charles A. Stickney, St. Paul, Minn., and others.

The part of the foundry of the Pomeroy Machine Co., Pomeroy, O., engineers, founders and machinists, which was recently damaged by fire will be rebuilt. Contracts for all necessary equipment and supplies for the work have been let. The total loss did not exceed $10,000.

The Hudson Valley Foundry Co., 49 Teller street, Kingston, N. Y., which was recently incorporated, has leased a building, 90 x 200 feet, and will engage in the manufacture of architectural and machine castings. J. J. Murphy is president of the company, which is capitalized at $5000.

A recent increase in capital was made by the Decatur Brass Works, Decatur, Ill., brass founders and finishers, in order to care for an increase in its business, and to enable it to enlarge its plant. The plant enlargement will not be undertaken until the spring of 1920, according to H. J. Maekey, vice president.

The Southern Electro Metals Co., Scott building, Lynchburg, Va., has been organized with $200,000 capital and will install an electric steel foundry, equipped with a 1-ton electric furnace, core oven, drying oven, annealing oven, heat-treating plant, sandblast equipment, traveling crane, etc. The company is now open for bids on this equipment. J. N. Keyzer is chief engineer.

A recent incorporation is that of the Midwest Castings Co., Middletown, O. The company is capitalized at $50,000, and will engage in the production of malleable castings for the automobile, electrical and agricultural industries. A pattern shop will also be operated. The immediate requirements of the company consist of a building, a malleable furnace, ovens and other foundry equipment. F. M. Wittlinger is general manager.

NEW TRADE PUBLICATIONS

CHAINS.—An illustrated booklet is being circulated by the Diamond Chain & Mfg. Co., Indianapolis, containing a brief history of the company. Illustrations of the company officials and the plant are given. A concise description of the plant is also given. One page of the booklet contains illustrations of chains manufactured by the company.

VERTICAL MILLING ATTACHMENT.—The Cleveland Milling Machine Co., Cleveland, recently published a circular describing and illustrating a vertical spindle attachment, which according to the circular will give the range of a vertical milling machine on ordinary classes of vertical milling work. This attachment is easily mounted and is capable of milling up to the capacity of the machine. The drive is taken from a gear fastened to the nose of the spindle, which drives the spur gear on the horizontal shaft and the spindle in turn is driven by large mitre gears.

SPIRAL PIPE.—Catalog No. 7 describing and illustrating smooth bore reinforced spiral pipe, valves, cast iron fittings, special steel fittings, hydraulic supplies, forged steel flanges and drop forgings is being distributed by the Standard Spiral Pipe Works, Chicago. In making spiral pipe two strips of steel of different widths are used. Both strips are rolled to shape on the edges and are interlocked and rolled down under high pressure. The strips of steel are first cut from sheets and the ends welded together. They then are placed on large spools, and fed into a special machine, out of which they come rolled to shape and interlocked in the form of pipe. Various data pertaining to the company's products are given.

MOTOR DRIVE.—The Oliver Machinery Co., Grand Rapids, Mich., recently published a 4-page leaflet in which a universal motor drive for double spindle shapers is described and illustrated. According to the leaflet, the drive consists of a heavy, ribbed floor plate supporting two adjustable cast-iron columns, each of which carries a vertical motor sliding in gibbed ways or with clamp, having a hand wheel and screw device which by the aid of a scale and pointer locates the motor pulleys in line with the shaper pulleys. The motors can be furnished for any kind of current. Several illustrations of the drive are given. A line drawing showing a floor plan of a universal motor drive operating in connection with a high speed double spindle shaper is presented.

LIFT-TRUCKS. — The Lewis-Shepard Co., Boston, recently published a 32-page booklet describing and illustrating industrial lift-trucks which it manufactures. According to the booklet, these trucks have a high lift and are equipped with a vertical release check. They can be used as trailers and the free handle with which they are equipped, enables operators to push them easily. The frame of the truck is no wider than the wheel base. Wheels can be taken off as required. A universal joint with which it is equipped, permits the handle to swivel freely so that loads can be elevated with handle turned to one side. The truck is of malleable and steel construction. Many excellent illustrations show the trucks in actual operation.

RODS AND WIRE.—An interesting booklet describing and illustrating welding rods and wire manufactured by the American Rolling Mill Co., Middletown, O., is being distributed by the Page Steel & Wire Co., New York. A brief treatise on how the American Rolling Mill Co. and the Page Steel & Wire Co. developed its welding rods and wire, and other data concerning American Rolling Mill Co. products are given. Numerous illustrations show the various welding uses to which the rods and wires can be put. A useful part of the booklet is that section devoted to tables, etc. This contains, a heat color scale; conversion tables of Fahrenheit and Centrigrade scales; electrical units; metric conversion table; comparison of wire gages, and other valuable data.

CRANES.—A well illustrated 32-page booklet is being circulated by the Morgan Engineering Co., Alliance, O., in which the prominent features of cranes manufactured by the company are described. The cranes are built for all capacities, for any required span, with one or more hoists, and for direct or alternating-current. End carriages and trolley frames are made of semisteel castings or cast steel. Gears are of steel with teeth cut from solid stock. Bearings are in alignment so that any shaft with gears in place may be removed without disturbing other parts. Flanged couplings are used on the bridge line shafting. Guards are provided for all gears. An interesting feature is that alternating-current cranes are equipped with both electric and mechanical brakes. The booklet contains minute descriptions of the various parts of the cranes, including a patented mechanical brake. Illustrations of the parts described are given, as well as a number of actual installations.

ELECTRIC FURNACES.—The Electric Furnace Co., Alliance, O., has prepared a 24-page illustrated booklet in which electric furnaces for melting nonferrous metals are described and illustrated. Three types of furnaces are shown. These are the resistance type; the non-tilting or tapping type and the pit-type crucible furnace for melting precious metals. The resistance type furnace chamber is made of special shaped brick, and has a bowl shaped hearth. Two carbon electrodes carry the current. The non-tilting type furnace is similar to the hearth and car types. The resistance process is applied with a rectangular hearth and refractory troughs running lengthwise in the furnace. Material is charged through motor operated doors at either end of the furnace. The small pit-type precious metal furnace has openings placed at the top through which crucibles are handled. These are supported on fire-brick pedestals. Other data pertaining to these furnaces are given, including a number of tables, etc. Numerous furnace accessories, including a special transformer and an oil-break switch, are described.